

UNITED STATES OF AMERICA

+ + + + +

DEPARTMENT OF HEALTH AND HUMAN SERVICES

+ + + + +

CENTERS FOR DISEASE CONTROL AND PREVENTION

+ + + + +

NATIONAL INSTITUTE FOR OCCUPATIONAL
SAFETY AND HEALTH

+ + + + +

FERNALD WORKGROUP

+ + + + +

WEDNESDAY, APRIL 22, 2009

+ + + + +

The workgroup convened in the
Zurich Room of the Cincinnati Airport Marriot,
Hebron, Kentucky, at 9:30 a.m., Bradley
Clawson, Chairman, presiding.

PRESENT:

BRADLEY P. CLAWSON, Chairman

MARK GRIFFON, Member

PAUL ZIEMER, Member

ROBERT PRESLEY, Member

PHILLIP SCHOFIELD, Member

THEODORE M. KATZ, Acting Designated Federal
Official

IDENTIFIED PARTICIPANTS:

JIM NETON, NIOSH ORAU
MARK ROLFES, NIOSH ORAU
ROBERT MORRIS, NIOSH ORAU

JENNIFER HOFF, NIOSH ORAU
BRYCE RICH, NIOSH ORAU
LEO FAUST, NIOSH ORAU
JOHN MAURO, SC&A
ARJUN MAKHIJANI, SC&A
LYNN ANSPAUGH, Consultant to SC&A
JOE FITZGERALD, SC&A

JOHN STIVER, SC&A
HANS BEHLING, SC&A
BOB BARTON, SC&A
HARRY CHMELYNski, SC&A
KATHY BEHLING, SC&A
NANCY ADAMS, Contractor to NIOSH
EMILY HOWELL, HHS

ROY LLOYD, HHS
ISAF al-NABULSI, DOE
RAY BEATTY, On Behalf of Petitioner

ALLEN CALLAWAY, Petitioner

SANDRA BALDRIDGE, Petitioner

1 P R O C E E D I N G S

2 9:38 a.m.

3 MR. KATZ: Good morning everyone.

4 And welcome. This is the Fernald Working
5 Group of the Advisory Board on Radiation
6 Workers Health. My name is Ted Katz and I'm
7 the Acting Designated Federal Official for the
8 Advisory Board.

9 And sorry we're, you know, five or
10 seven minutes late. We had some logistical
11 things to deal with because we have a large
12 presence at the meeting today.

13 So we're going to begin this with
14 roll call beginning with the Board members in
15 the room. And if the Board members would
16 identify themselves starting with the Chair
17 and speak to conflict of interest as well.
18 That would be great. That goes for everybody.

19 CHAIR CLAWSON: Brad Clawson,
20 Working Group Chair. Not conflicted.

21 MEMBER GRIFFON: Mark Griffon,
22 Work Group Member. Not conflicted on Fernald.

1 MEMBER ZIEMER: Paul Ziemer, Work
2 Group Member. Not conflicted.

3 MEMBER PRESLEY: Robert Presley,
4 Work Group Member. Not conflicted.

5 MEMBER SCHOFIELD: Phillip
6 Schofield, Work Group Member. Not conflicted.

7 MR. KATZ: Okay. And then
8 checking on the line just to be certain we
9 don't have any Board members, do we, on the
10 line?

11 (No response.)

12 MR. KATZ: Okay. Then the room,
13 the NIOSH ORAU Team please.

14 DR. NETON: Jim Neton, conflicted
15 at Fernald.

16 MR. ROLFES: Mark Rolfes, NIOSH
17 health physicist. No conflicts of interest.

18 MR. MORRIS: Robert Morris, ORAU
19 Team. No conflict.

20 MS. HOFF: Jennifer Hoff, ORAU
21 Team. No conflict.

22 MR. KATZ: And on the line? NIOSH

1 ORAU Team?

2 MR. RICH: Bryce Rich, ORAU Team.

3 No conflict.

4 MR. KATZ: I'm sorry. Can you
5 repeat that please?

6 MR. RICH: This is Bryce Rich.

7 MR. KATZ: Bryce Rich.

8 MR. RICH: ORAU Team. No
9 conflict.

10 MR. KATZ: Thank you. Welcome,
11 Bryce.

12 MR. FAUST: Leo Faust, ORAU Team.
13 No conflicts.

14 MR. KATZ: Any others from the
15 NIOSH ORAU Team on the line?

16 (No response.)

17 MR. KATZ: Okay. And then in the
18 room from SC&A?

19 DR. MAURO: John Mauro, SC&A. No
20 conflict.

21 MR. MAKHIJANI: Arjun Makhijani.
22 I have been declared conflicted on Fernald.

1 MR. KATZ: Speak up please.

2 MR. MAKHIJANI: I'm Arjun
3 Makhijani. I've been declared conflicted on
4 Fernald.

5 MR. ANSPAUGH: Lynn Anspaugh. I'm
6 a consultant to SC&A. No conflict on Fernald.
7 I have a general conflict that is having been
8 an expert witness.

9 MR. FITZGERALD: Joe Fitzgerald,
10 SC&A. No conflict.

11 MR. STIVER: John Stiver, SC&A.
12 No conflict.

13 MR. KATZ: And on the line?
14 Anybody from SC&A?

15 DR. BEHLING: Hans Behling. No
16 conflict.

17 MR. KATZ: Welcome, Hans.

18 DR. BEHLING: Thank you.

19 MR. BARTON: Bob Barton, SC&A. No
20 conflict.

21 MS. BALDRIDGE: Harry Chmelynski,
22 SC&A. No conflict.

1 MR. KATZ: Harry Chmelynski.

2 Okay. And then other federal
3 employees or contractors in the room first.

4 MS. HOWELL: Emily Howell, HHS.

5 MR. KATZ: And then on the line,
6 any federal employees or contractors? HHS?
7 DOE? DOL?

8 MR. LLOYD: Roy Lloyd, HHS. No
9 conflict.

10 MR. KATZ: Welcome, Roy.

11 MR. LLOYD: Thank you.

12 DR. al-NABULSI: Isaf al-Nabulsi,
13 DOE. No conflicts.

14 MR. KATZ: Okay. And then in the
15 room, SEC petitioners or other members of the
16 public who would like to self-identify?

17 MR. BEATTY: Ray Beatty, former
18 site worker. I'm here on behalf of the
19 petitioner.

20 MR. KATZ: Welcome, Ray.

21 MR. CALLAWAY: Allen Callaway,
22 former worker at Fernald.

1 MR. KATZ: Welcome, Allen.

2 And on the line, do we have any
3 members of the public who like to self-
4 identify?

5 MS. BALDRIDGE: Sandra Baldrige,
6 petitioner.

7 MR. KATZ: Oh, welcome, Sandra.
8 We were wondering whether you would be here or
9 on the line.

10 MS. ADAMS: Hey, Ted, it's Nancy
11 Adams. I went to hit my mute button and
12 disconnected you.

13 MR. KATZ: Sorry. But welcome,
14 Nancy. So that's -- Nancy is a contractor to
15 NIOSH. No conflict.

16 Any other members of the public or
17 staff of the Congressional offices?

18 (No response.)

19 MR. KATZ: Okay, then, just a
20 couple other things. For everybody who is on
21 the line, just to remind you, I think all of
22 you are probably familiar but mute your phone

1 except when you are speaking to us. And if
2 you don't have a mute button, use star six.

3 Please disconnect. Don't use your
4 hold button if you need to go away from the
5 phone for some time because the hold button
6 will interfere with the call.

7 And I would just mention for
8 everyone here in the room since we have
9 members of the public here to please just keep
10 in mind Privacy Act concerns when you discuss
11 material.

12 And with that, Brad, it's all
13 yours.

14 CHAIR CLAWSON: Well, I'd like to
15 welcome everybody here today. We're here for
16 the Fernald Work Group. It has been a long
17 time since we've met. The last time we met
18 was 11/13, I believe -- that's '07 but it was
19 November of last year that we met.

20 And in that, we had numerous
21 issues that came up but today we're going to
22 discussing the sampling plan that SC&A has put

1 forth, recycled uranium, K-65 silos. We're
2 going to be talking a little bit about thorium
3 and the radon breath analysis.

4 And we've had -- John, SC&A has
5 sent out several papers on that. We want to
6 make sure that everybody has those papers.
7 And, John, you were to find out which ones
8 were PA-cleared.

9 DR. MAURO: Yes, I got
10 confirmation that the sampling plan and the RU
11 report have been cleared.

12 CHAIR CLAWSON: Okay.

13 DR. MAURO: However, the radon
14 contamination from the silos report has not
15 been cleared however right now I have it with
16 Emily who is looking over the key pages.
17 There are four pages in there that I would --
18 that she's going to look at right now.

19 And hopefully she'll clear it.
20 And I will be able to make copies and
21 distribute those four pages. That's all we
22 really need right now for the purpose of this

1 meeting is to go over those four pages.

2 Meanwhile, the report itself, the
3 entire report, it's possible to get that
4 cleared shortly also. But right now I'm
5 confident that we'll have at least the key
6 pages available for our visitors this year
7 that would like the cleared material.

8 So that's the only report. We
9 probably won't get to that report based on the
10 order I think we're going until this
11 afternoon. So we should be well poised to do
12 that.

13 CHAIR CLAWSON: Okay. So the
14 sampling plan, is that cleared?

15 MEMBER ZIEMER: That's cleared.

16 CHAIR CLAWSON: That's cleared.

17 Do we have copies for the public?

18 DR. MAURO: No, all I did was send
19 out electronic versions of the reports late
20 last week --

21 CHAIR CLAWSON: Okay.

22 DR. MAURO: -- to the work group

1 and NIOSH. I do not have extra copies. We
2 can have that done.

3 CHAIR CLAWSON: Okay.

4 DR. MAURO: Mine is heavily marked
5 up. If someone has a clean one, we can get
6 copies made.

7 CHAIR CLAWSON: I've got a --
8 probably a clean one. I'll take care of that
9 afterwards.

10 MEMBER ZIEMER: Did the petitioner
11 get copies, cleared copies?

12 DR. MAURO: They can.

13 MEMBER ZIEMER: Did Sandra --

14 MR. KATZ: Sandra, have you
15 received any materials for this meeting from
16 maybe Laurie Breyer?

17 MS. BALDRIDGE: Yes, I do.

18 MR. KATZ: Okay. Thank you.

19 DR. BEHLING: Excuse me, this is
20 Hans Behling, SC&A. And I'm going to be
21 asking John to identify those four pages in
22 question that you say are likely to be at

1 least cleared by the time we discuss it.

2 DR. MAURO: Sure. I just handed
3 the report and the four pages to Emily. So I
4 don't have it in front of me. But as soon as
5 she returns -- oh, she's here. Hold on.

6 Hans, the pages that I was
7 planning on distributing to everyone -- have
8 it cleared and distributed is page two, three,
9 five, and ten.

10 DR. BEHLING: Just a quick
11 question.

12 DR. MAURO: Yes?

13 DR. BEHLING: If those are the
14 pages you are able to hand out to participants
15 who are present in the room, is it possible
16 for me to go outside of those pages? Because
17 I was hoping to discuss a few things that are
18 not contained on those pages.

19 DR. MAURO: Absolutely. We just
20 can't hand out -- in other words we can speak
21 about them, of course, with the guidelines not
22 to divulge any Privacy Act materials. But

1 certainly you can speak to any aspect of the
2 report that you'd like to, sure.

3 DR. BEHLING: Well, I can assure
4 you there's no Privacy Act issues here in the
5 entire report.

6 DR. MAURO: Yes and Emily is here
7 to make sure that we stay within the
8 boundaries. Okay?

9 CHAIR CLAWSON: And I'd also like
10 to bring up -- everybody knows that we work
11 from a matrix on this. And it's been kind of
12 so long and so forth. We're just reviewing
13 the matrix right now. So, John, if you'd like
14 -- if we could, I'd like to start from the
15 sampling plan and then to the recycled uranium
16 stage contents with the matrix.

17 DR. MAURO: Yes.

18 CHAIR CLAWSON: Would that be all
19 right?

20 DR. MAURO: By way of
21 introduction, last night I read through the
22 transcripts from the October meeting just to

1 make sure I got my arms around the issues.
2 And in addition to the subjects that we are
3 planning to discuss today, I did notice that
4 there were a few other items that came up
5 during that meeting.

6 If you'd like, I could -- I sort
7 of made a list of the things that we are going
8 to cover. But the other things that we talked
9 about and sort of left open that perhaps we
10 should not lose track of.

11 We could do that now or we could
12 just put together a matrix at some future date
13 to make sure we pick those up. You know?

14 CHAIR CLAWSON: I think we could
15 start in.

16 DR. MAURO: We could start right
17 away.

18 CHAIR CLAWSON: And in closing, we
19 can review through that and make sure that we
20 have captured everything and we'll be able to
21 look into the matrix on that.

22 DR. MAURO: Fine.

1 Then with that, let's start with
2 the sampling plan. This is a document I
3 believe was sent out as PA-cleared, as DOE-
4 cleared. And it's dated March 2009 on the
5 cover page. And it's title Draft Sampling
6 Plan for Use in Evaluating the NIOSH Internal
7 Dosimetry Coworker Model for Fernald Workers.

8 A little history here. When we
9 previously met, SC&A did come to the table
10 with a sampling plan, draft sampling plan that
11 was designed to evaluate the completeness of
12 the dataset, completeness in terms of is there
13 adequate data for the different buildings? Is
14 there adequate data for the various categories
15 of workers? In terms of what percent of the
16 workers had bioassay data -- this is basically
17 bioassay data.

18 During that meeting, it was
19 decided no, no, no, we don't want to do that.
20 We want to do something a little different.
21 We want to do that but we want to do more
22 because between -- because by the time we had

1 the meeting in October, NIOSH had issued a
2 coworker model, a very specific coworker model
3 on how doses, internal doses from intake of
4 uranium would be reconstructed for those
5 workers who had -- did not have data or had
6 limited data.

7 A very important underpinning of
8 all this is -- the general concept was that
9 well, there was a lot of data. And for most
10 workers, you would not need to use a coworker
11 model. But there will be some. So the
12 coworker model was put in place.

13 We were asked to develop a
14 sampling plan that would accomplish a number -
15 - at that last meeting -- accomplish a number
16 of objectives. One is completeness, adequacy,
17 but most important, we were asked to develop
18 a plan that would -- when you are finished
19 doing the sampling, you could feel confident
20 that the plan will not underestimate the doses
21 to workers that have the potential for high-
22 end exposures. That somehow that coworker

1 model did not underestimate at least some of
2 the workers that had a higher potential for
3 exposure. And that's what we developed.

4 We developed basically -- the
5 actual sample -- the number of samples are not
6 in the plan. What we really have here is the
7 strategy for where we would sample, which
8 workers we would sample, what years we would
9 sample, what buildings we would sample. But
10 we don't actually have the number and the
11 names of the workers that we would actually
12 sample in the plan.

13 That's something that we didn't
14 do. We thought it was more appropriate to
15 discuss in general whether or not this is, in
16 fact, the sampling plan that will meet your
17 needs.

18 So with that as a sort of preface,
19 I'd like to start to walk through this. If
20 you would look -- I'd like to first describe
21 what the coworker model is. If you wouldn't
22 mind opening up on your screen to page two of

1 the report. The first thing we did in this
2 report is to describe the coworker model that
3 NIOSH developed.

4 And by the way, Jim, if in any way
5 I misrepresent our understanding of the
6 coworker model, please help out.

7 You'll see on page two, Table 1-1,
8 this is a look-up table that is your coworker
9 model. Let's envision we have a worker that
10 you wanted to reconstruct the internal dose
11 from the inhalation of uranium but you don't
12 have a complete dataset on bioassay data or
13 you don't have any data on bioassay data for
14 this worker. And you want to reconstruct his
15 internal exposures.

16 You go to -- there are basically
17 three tables. One on page two and two on page
18 three. The first table is -- if you believe -
19 - you first ask yourself the question okay,
20 here we have a worker. He has a certain type
21 of cancer. What type of uranium, F, M, or S
22 would give the highest dose to the organ of

1 concern?

2 Let's say you determine it was a
3 lung cancer, just for an example. That being
4 the case, you would go to the table on page
5 three that I -- it's Table 1-3. Basically
6 that's the look-up table for Type S uranium.

7 And what it says is okay, if the
8 worker worked from 1/1/52, start of
9 operations, to 12/31/53, you would assume that
10 he would have a distribution. You would
11 assume his intake rates for uranium Type S was
12 8,197 micrograms per day with a geometric
13 standard deviation of 3.44.

14 So it becomes just a look-up
15 table. And for that worker, you know how many
16 years he worked there. You would assign those
17 intake distributions to that worker. And you
18 would run it and get your dose to the organ of
19 concern.

20 And now the question becomes --
21 and these are the additional side pieces which
22 we are going to talk about a little more

1 later, is in addition, it is assuming that
2 those micrograms per day ingested were at two
3 percent enriched uranium. And what is being
4 assumed is across the board, everyone is going
5 to be assumed to have two percent enriched
6 uranium.

7 We looked very carefully at that
8 assumption to convince ourselves that that, in
9 fact, is a reasonable if not bounding approach
10 and this was discussed at the last meeting.
11 And the answer was yes.

12 Even though there were some
13 workers that might have had six, seven, eight,
14 ten percent enriched uranium that they worked
15 with, it was generally for a relatively small
16 period of time.

17 So by assuming it was two percent
18 for his entire work history, that blends out,
19 so to speak, and the outcome is legally to be
20 a conservative assumption. So we are
21 comfortable with the two percent default
22 assumption embedded in this process.

1 There's also the question, and
2 we're going to get this in much greater
3 detail, on recycled uranium. The key to the
4 coworker model was to say okay, once you know
5 the activity or amount of uranium that was
6 inhaled, using the coworker model or using the
7 worker's actual data, you assume a certain mix
8 of plutonium-239, neptunium, technetium, and
9 other fission products as being the material
10 that goes along with the uranium as a default
11 intake.

12 This is the so-called recycled
13 uranium issue. We do have some concerns with
14 that. So unlike the two percent enrichment
15 where we're comfortable, we do have some
16 important concerns regarding recycled uranium.
17 That's the subject of a separate report that
18 we're going to go to after we finish this
19 report. And we'll get into some detail.

20 Okay. Now everyone has a pretty
21 good sense of this coworker model. Now the
22 question becomes --

1 DR. NETON: There's just one point
2 of clarification that I think will come
3 important later. If you notice, there is a
4 minimum GSB of three in these columns, those
5 are not calculated GSBs. That is the minimum
6 GSB that we would assign to a distribution
7 that was measured acknowledging the fact that
8 at a minimum, there is a GSB of three
9 associated with the biological variability of
10 the models and such.

11 So that's important because then
12 that rises to the 84th percentile when the
13 comparison is done by SC&A later.

14 DR. MAURO: Okay. Good.

15 MEMBER ZIEMER: So it is only
16 three if there's not information to show that
17 it's higher than that.

18 DR. NETON: If the GSB, for
19 instance, came out 1.6, we would automatically
20 at a minimum have a GSB of three which will
21 kind of increase the 84th percentile of
22 distribution. So I think there have been some

1 mismatched comparisons later on. But --

2 DR. MAURO: Okay. You're right.

3 There is that.

4 All right. Let's go on. Now you
5 say to yourself, okay, so now we have default
6 intake rates. The way those default look-up
7 table intake rates were obtained, if you go to
8 page four, you'll see a table called Table 2-
9 1.

10 What this presents here is an
11 excerpt of a four-page table that is in the
12 coworker model that says this is the data that
13 was used in terms of excretion rates. That is
14 micrograms per day of uranium excreted in
15 urine by year. In fact, it's actually by
16 quarter.

17 The only place where they've
18 rolled up information is in the '52 and '53
19 time period where there wasn't enough data to
20 parse it by quarter. But beginning in '54,
21 there was sufficient data to sort by quarter.

22 This table goes on, I believe,

1 into the '90s. I'm not sure but we can look
2 it up but it goes on for quite -- in other
3 words, you have quarterly data that goes on.

4 And what we basically have is the
5 excretion rate in micrograms per day at the
6 50th percentile and the 84th percentile, on a
7 log-normal distribution that was determined --
8 that was measured --

9 MR. ROLFES: John?

10 DR. MAURO: Yes?

11 MR. ROLFES: The data do go
12 through 2006.

13 DR. MAURO: 2006, thank you for
14 correcting me.

15 So I would first offer an
16 observation that this is quite a bit of data,
17 okay? So what you have is a dataset. We're
18 going to get into a little bit more detail on
19 how much data this is because right now we're
20 looking at a mean, median, and a standard
21 deviation or a geometric standard -- 84th
22 percentile. But, of course, that reflects a

1 number of individual samples of urine.

2 So what we did was say okay, let's
3 take our face value, this long table that goes
4 on for several pages, let's see if using this
5 we can match the intake rates that are on
6 those tables we showed you before. And we
7 did.

8 So given that this is a correct
9 representation, a complete, accurate
10 representation of the distribution of
11 excretion rates, we confirmed that the numbers
12 that are being used as the coworker model are,
13 in fact, compatible and consistent with the
14 excretion rate. So a minor point but, you
15 know, we did that check.

16 Now we're going to move on and get
17 to what's the heart of the matter. Let's jump
18 off to page eight.

19 And one of the things that this
20 report does is, besides being the foundation
21 upon which we could build a sampling plan, it
22 is also very informative in terms of getting

1 a feel for the amount of data that's out there
2 and its granularity so that each individual
3 around the table can make a judgment for
4 themselves whether or not this is a lot of
5 data that looks like it's rich and with a
6 great deal of granularity or there are places
7 where, perhaps, it is weak.

8 Attachment A, page eight, this is
9 the beginning of where SC&A started to go into
10 the HIS-20 database and started to sort
11 information. Now if you recall when we looked
12 at the data on page four -- I'll get to that
13 Table 2-1 -- it basically gave you by quarter
14 for each year.

15 Whoa, we said to ourselves, hold
16 the presses. Where could there be hidden
17 problems? And one of the things we said to
18 ourselves is a hidden problem could be that
19 well, listen, if I'm looking at a particular
20 year and I'm rolling up all the bioassay data
21 for hundreds of workers, maybe thousands of
22 bioassay samples, and I'm giving you the mean

1 and the standard deviation for that year, I
2 effectively have captured the full
3 distribution of bioassay samples observed in
4 that year. And it crosses all work categories
5 and it crosses all buildings.

6 So the first concern that we said
7 was what happens if within that array of data,
8 there might be a group of workers that have a
9 particular job function or a building in that
10 year that had a particular operations going
11 on, if I was to pull that group out
12 separately, which it hasn't been done in your
13 coworker model, is it possible I'll find that
14 the 50th percentile and 95th percentile or the
15 upper bound values are a lot different than
16 this so-called aggregate value?

17 If that's the case, we've got a
18 problem. So one of the first things we
19 started -- you know, that's how we started to
20 think about the problem. That is assigning an
21 aggregate 50th percentile and 84th percentile
22 for a given year to all workers, all work

1 categories, all buildings, you know, in theory
2 there could be a problem if there's some group
3 of workers that consistently had a higher-end
4 exposure in that year or maybe many years.

5 DR. NETON: And that is assuming
6 that that work category had no bioassay data -
7 -

8 DR. MAURO: Correct. Now I would
9 want -- and that's -- but I want to get you
10 into the way we are thinking about the
11 problem. And this is a recurring theme in all
12 of the work we do. And that is -- the
13 recurring theme is granularity.

14 Whenever you have a group of data
15 for a given year or a given facility and you
16 have a mean and you have a standard deviation
17 on the data, you know, where things are sort
18 of pooled, and if it turns out there is a
19 significant fraction of workers that really
20 don't have data or have adequate data, you
21 have to ask yourself for the place where we do
22 have data and we do build a distribution from

1 that data, will we pick off some parameters
2 for that distribution?

3 Is it possible that there is a
4 group of workers that were unmonitored and
5 that fall at the high-end of that distribution
6 and we're going to underestimate their dose?

7 Now I would be the first to agree
8 that in this site, and you'll see as we get
9 through this, once you get past the first
10 couple of years, we're talking about over 90
11 percent of the workers that were working there
12 have bioassay data. So the need to use the
13 coworker model is the exception to the rule.

14 That is the vast majority of
15 claimants will -- their dose reconstructions
16 for internal exposure for an inhalation, an
17 ingestion of uranium is going to be done using
18 their data.

19 And the question we're asking
20 ourselves now is well, for those individuals
21 that we may have to resort to the coworker
22 model, how robust is that coworker model? And

1 what kind of sampling plan can we implement to
2 convince ourselves that there are not going to
3 be groups of workers that we are going to
4 underestimate.

5 All right. Now --

6 MR. MORRIS: Can I ask -- I have a
7 question --

8 DR. MAURO: Sure.

9 MR. MORRIS: -- at this point.

10 The concept you are proposing then is that
11 there is -- we've got population data and you
12 are subdividing the population into
13 subpopulations --

14 DR. MAURO: Yes.

15 MR. MORRIS: -- and say how
16 representative is that.

17 DR. MAURO: Yes.

18 MR. MORRIS: How small can a
19 subpopulation go before it becomes an
20 individual.

21 DR. MAURO: We're going to talk
22 about that.

1 MR. MORRIS: Okay.

2 DR. MAURO: Good question.

3 MR. MORRIS: And I think that it
4 really points to the big picture is that, you
5 know, you, by definition, can find
6 subpopulations that are above me.

7 DR. MAURO: Well, you're going to
8 see what we propose as a way of testing how
9 robust and favorable this particular coworker
10 model is. And around the table we can judge
11 whether or not that is a fair test.

12 And in the end, we're going to
13 actually suggest a test. Okay, what is it
14 we're going to do to -- what do we suggest we
15 do to convince ourselves that yes, this looks
16 pretty good -- or no, it may not be.

17 We will discuss the test. We
18 don't know what the results are going to be.
19 But we're going to discuss whether we think
20 that is a fair test.

21 DR. NETON: I'd like to make one
22 observation for what it is worth and I'm going

1 to hold off on this one. I'll just throw this
2 on the table as you discuss the plan.

3 If, by definition, we have
4 bioassay data for more than 90 percent of the
5 claimants or 90 percent of the workers, it
6 probably holds true for the claimants. I
7 think Mark told me it is 92, 93 percent of the
8 cases have bioassay data. Then it seems to me
9 that this sampling plan is looking for the
10 proverbial needle in the haystack.

11 Where is that one group that could
12 have been missed when, in fact, it would seem
13 to be more efficient to go look at the 50
14 people that don't have bioassay data, identify
15 their work categories, and then go back and
16 start looking and saying are those classes of
17 workers really the ones that had potentials
18 for large exposures to which if we would apply
19 this coworker model, we'd be underestimating
20 their dose.

21 You're looking at potentially
22 400,000 records here. And we've got a

1 thousand claimants at Fernald roughly. And
2 let's say 95 percent have bioassay. There are
3 50 that probably have zero bioassay data in
4 that ball park.

5 And so that why would one look at
6 400,000 records to find the ones that --

7 DR. MAURO: Well, remember --

8 MEMBER GRIFFON: Instead of
9 hypothetical categories, look at real
10 categories.

11 DR. MAURO: Let me give you this,
12 in a given quarter, the question is how many
13 people are we talking about? We're talking
14 about two, three, 4,000 workers who have
15 unique social security numbers. And what
16 we're saying is in 1952 and '53, 90 percent of
17 those, on that order -- in 1952, 90 percent
18 had no bioassay sample. So there's something
19 -- '52 looks a little weak.

20 In '53, 58 percent had no bioassay
21 data out of 2,400. But eventually -- let me
22 show you how I'm looking at this -- eventually

1 once you reach 1957, 95 to 98 percent of the
2 workers have some bioassay data. At least one
3 if not more.

4 So right off the bat I would say
5 you just described a different strategy. And
6 we're talking about on the order of anywhere
7 from 3,000 to 4,000 workers. Now let's say it
8 turns out two percent of 4,000 workers or
9 three percent of 4,000 workers have no
10 bioassay data. You're saying that we can go
11 in and take a look at a sample from those and
12 see whether or not there is reason to believe
13 that based on their work history, they may be
14 people who could have had a high -- could have
15 been exposed.

16 Or is there evidence that no,
17 these are workers that very little potential
18 for exposure. We did not propose that. That
19 is --

20 DR. NETON: One more point of
21 clarification, too, is you have to look at how
22 we apply these coworker models or how we apply

1 bioassay data in general. If a worker had no
2 bioassay data until 1957, we would not apply,
3 more than likely -- I can't think of a case of
4 how we would do that -- this coworker model
5 would fill in '52 to '56. We would calculate
6 some chronic exposure intake that could have
7 occurred and resulted in that bioassay value
8 in 1957.

9 So the mere fact that there are a
10 small fraction of workers monitored in '52 to
11 '56 does not prevent us from doing bioassay
12 data for workers who were still on in '57 and
13 moving forward.

14 DR. MAURO: Exactly. Very good
15 point. So you have to -- so you're saying --
16 let's say we have -- we're in 1957, we -- by
17 the way, all these workers are workers that
18 were there starting in the '70s. All right,
19 so you're saying we have a worker that was
20 there beginning from '52 working right through
21 1970. And we start to have plenty of data for
22 him let's say starting in '57.

1 And now you say well, we have to
2 fill in the earlier years. You would fill in
3 those earlier years based on a best fit?

4 DR. NETON: Yes.

5 DR. MAURO: As opposed to going to
6 the coworker model. When would you use the
7 coworker model?

8 DR. NETON: The coworker model has
9 zero data, essentially zero data for anyone.

10 DR. MAURO: Any worker -- there's
11 a very good chance that there's no workers
12 that never had any bioassay --

13 MR. ROLFES: Let's plug in some
14 numbers, you're saying 3 to 4,000 workers at
15 Fernald. I'll give you, you know, some
16 comparison to the number of claims that we've
17 received at NIOSH for dose reconstruction.

18 We've received 1,040 claims versus
19 the, you know, larger population at the total
20 Fernald site.

21 Before you had mentioned some lung
22 cancer cases. That was the -- you know, that

1 was what you had cited in your report.

2 DR. MAURO: As an example.

3 MR. ROLFES: As an example,
4 correct. So what I did is went and looked to
5 see the number of lung cancer claims that we
6 had received for dose reconstruction that were
7 less than 50 percent probability of causation.

8 Then what is did is went and
9 looked at their job categories and the amount
10 of data that they had. I found roughly 16
11 claims that had less than 50 percent
12 probability of causation and looked through
13 the job categories in the data that we've
14 received. There were approximately eight
15 claims that did not have any data or did not
16 have any internal dose reconstruction
17 information in there that we could use.

18 So if you look at the actual job
19 categories, there's a variety of categories.
20 And let's see -- if you take a look, some of
21 these people have very low latency periods so
22 there's not very much time in between the

1 first exposure and the date of diagnosis.

2 So essentially for some of those
3 people that have less than five years, for
4 example, for a solid tumor, five years of
5 latency, no matter what uranium intake we
6 assign -- so I don't foresee this being a
7 large population of claims.

8 DR. MAURO: Neither do I.

9 MEMBER GRIFFON: Can I step back?
10 Can I go back one step further? And this is,
11 I think, why I thought and I'm trying to catch
12 up with all the matrices but this is why we
13 decided to question -- go down the path of
14 questioning data completeness and validity
15 more so than the coworker model.

16 This is like deja vu all over
17 again. But that's the problem with having
18 these meetings so far apart. I mean this is
19 very much like the Rocky Flats situation. You
20 know the coworker model was not used for many
21 claims, right?

22 So we ended up looking at the

1 actual -- a fraction of the claimant's data
2 and saying okay --

3 MR. KATZ: Can we hold? Can we
4 hold? We've lost the line. I don't know when
5 we lost it.

6 (Whereupon, the foregoing matter
7 went off the record at 10:13 a.m.
8 and resumed at 10:14 a.m.)

9 MR. KATZ: Hello, this is Ted Katz
10 with the Advisory Board on Radiation Worker
11 Health. We lost the line. It was
12 disconnected briefly.

13 But can someone on the line just
14 tell me how long have we lost the line for?

15 MR. RICH: It's been about ten
16 minutes.

17 MR. KATZ: Ten minutes, okay.
18 We're on the same issue. There's been a lot
19 of interesting discussion but it would be very
20 hard to recap it because it has been on a lot
21 of different points.

22 We're sorry about that. It's just

1 a physical problem here in the room.

2 MEMBER GRIFFON: But anyway, to
3 finish my point, you know, the reason we went
4 to data completeness there in looking at the
5 data, the completeness of each claim in the
6 file, you know, we looked at it and said okay,
7 is there enough data there to reconstruct
8 dose?

9 And this is to Jim's issue, maybe
10 they didn't have many singles but they had
11 enough to do a chronic exposure and bound
12 their dose. It was also for the external
13 side. And I know this was somewhere in that
14 transcript.

15 But, you know, so then somehow we
16 -- I don't know if we lost this whole data
17 completeness side and validity. I know that
18 at some point NIOSH did look at HIS-20
19 compared to raw data. And they gave a report
20 on that.

21 But I don't know that we ever
22 looked at this completeness of the individual

1 records. So we know that we're not going to
2 rely on coworker models very much.

3 The question is is there enough
4 data in there because part of the reason this
5 -- at least for me, a part of the reason this
6 comes up is that this question of in 1970, I
7 think, the database itself only has people
8 that were still working there in 1970 or
9 something. So we want to make sure in their
10 hard copy records that everything is there or
11 nothing is there to reconstruct their doses.
12 And we sample a fraction of individuals.

13 DR. NETON: I'm not sure where
14 that 1970 date came from.

15 MEMBER GRIFFON: Oh, okay.

16 DR. NETON: We need to look into
17 that. I was talking to Mark about that this
18 morning. I mean I was there when this company
19 was put on line. And I was reasonably certain
20 we had everybody transfer over from the
21 various legacy computer systems. So we need
22 to look into that. I'm a little bit confused

1 by --

2 MR. MORRIS: That sounds like a
3 different site to me actually.

4 DR. NETON: I don't -- we made a
5 very concerted effort to consolidate all of
6 the legacy databases.

7 MEMBER GRIFFON: That may have
8 been true at Rocky Flats actually now that I
9 think about it, yes.

10 DR. NETON: We will look into it.

11 MEMBER GRIFFON: At any rate,
12 still the issue that I have stands with the
13 question of, you know, validating the -- or
14 data completeness and validation rather than
15 -- I mean this sort of tests the coworker
16 model and I'm not dropping this issue but, you
17 know, I'm sort of stepping back to say how did
18 we eliminate those other two.

19 DR. MAURO: Well, at the last
20 meeting, we did have a sampling plan which was
21 designed to make a statement about
22 completeness.

1 That is the outcome of that last
2 proposed sampling plan would have been we're
3 95 percent confident that at least 50 percent
4 of the workers in this group have bioassay
5 data with a sampling plan that had that as its
6 end result.

7 That is we could say with some
8 level of confidence what percent of the
9 workers had at least a certain number of
10 bioassay samples. It was a completeness
11 statement. It was designed around the
12 necessity of completeness.

13 During the course of our workgroup
14 meeting, we went on for most of the meeting --
15 I read the transcript last night -- saying
16 that well, you know, now that there is a
17 coworker model, we're still interested in
18 completeness but we're even more interested in
19 making sure that the coworker model is
20 claimant-favorable, bounding. Is there a way
21 to sample the coworker -- is there a way to
22 sample the data to convince us that the

1 coworker model is robust?

2 So the attention shifted away from
3 completeness -- and this is the language that
4 is in the transcript. So we went back to the
5 drawing board and came up with this which I
6 think --

7 MEMBER GRIFFON: Well, I think
8 we're talking past each other a little bit
9 still. I mean I'm not talking about
10 completeness of the electronic database. I'm
11 talking about completeness of the individual
12 files for workers.

13 And I thought in our last meeting
14 that we had an action to propose an approach
15 to sample groups -- so we did talk about
16 targeting the jobs with higher potential for
17 exposure.

18 DR. MAURO: We had that.

19 MEMBER GRIFFON: Yes.

20 DR. MAURO: But we didn't go into
21 the hard copy. Everything that we did was
22 electronic.

1 MEMBER GRIFFON: Right. Right.

2 DR. MAURO: Everything we were
3 working with was the electronic database. We
4 did not do any things like we did on NTS where
5 we went into handwritten records or hard copy
6 scanned records and go into that original
7 data.

8 And when we discussed this matter
9 at the last meeting, there was some discussion
10 about was the data, the hard copy of scanned
11 data faithfully transcribed from the original
12 set into the HIS-20 database.

13 And there was a report prepared
14 that's on the record that NIOSH presented that
15 I do not believe we reviewed that was quite
16 extensive showing that it was faithfully
17 transcribed.

18 MEMBER GRIFFON: Yes, and that's
19 NIOSH's report, right, right.

20 MR. MAKHIJANI: I'm looking at the
21 completeness plan that we sent to the working
22 group before the last working group meeting

1 dated October 6th and the design of that
2 working plan -- well, let me just read it --
3 in general we wish to determine if workers at
4 Fernald were monitored during specified time
5 periods and with what frequency.

6 The main metric to be used is the
7 frequency of actual monitoring for the
8 subpopulation of workers compared to the plan
9 frequency, once a week, once a month, or once
10 a year according to job title.

11 That was the design of the plan
12 that you brought from which then there was a
13 new instruction given to go back and design a
14 new plan.

15 DR. MAURO: That's in here. In
16 other words, in effect, we didn't implement
17 that plan but as we go through this, you can
18 decide for yourself whether or not to a large
19 extent that question has been answered. So
20 it's not going to take that long.

21 MEMBER ZIEMER: Could I ask one
22 other clarification question, though, John?

1 DR. MAURO: Yes, sir.

2 MEMBER ZIEMER: On the column
3 where you give the workers with no samples, as
4 I understand it, you are only talking about
5 for that year.

6 DR. MAURO: Yes.

7 MEMBER ZIEMER: For example --

8 DR. MAURO: Yes.

9 MEMBER ZIEMER: -- that worker
10 might have gotten picked up --

11 DR. MAURO: Yes.

12 MEMBER ZIEMER: -- in the
13 subsequent year --

14 DR. MAURO: Yes. And that's the
15 point Jim was making.

16 MEMBER ZIEMER: That's the same
17 point then, okay.

18 DR. MAURO: Yes.

19 MEMBER ZIEMER: So the idea that,
20 for example, in '53 that 59 percent of the
21 workers have no bioassay, that doesn't mean
22 that 59 percent of the workers have no

1 bioassay in their record. Only for that --

2 DR. MAURO: Absolutely correct.

3 DR. NETON: In fact, we know in
4 the claimant population, 90 percent-plus of
5 the claimants have some bioassay data.

6 MEMBER ZIEMER: Right. Right.

7 DR. MAURO: My -- I am trying to -
8 -

9 MEMBER ZIEMER: So this is really
10 -- it's something workers with no samples for
11 that year.

12 DR. MAURO: Absolutely. And
13 that's why the table is structured this way.

14 MEMBER ZIEMER: Yes. I
15 understand.

16 DR. MAURO: That's what it means.

17 Now I think it is important to
18 point out that this table demonstrates that at
19 least by year -- I realize this is rolled up -
20 - rolled up in this data are all the different
21 buildings and all the different job categories
22 -- but from the point of view as a function of

1 time, the percent of workers -- a large number
2 of workers that had bioassay data is enormous.

3 I would say that after looking at
4 data sets for quite some time now, five years,
5 they don't come any better than this. I'm
6 sorry I have to say that. This is complete in
7 terms of the percentage of workers that have
8 bioassay data.

9 Now you may have questions
10 regarding assumptions on recycled uranium.
11 But when you look at these data, except for
12 1952 and '53, once you start moving into the
13 late '50s, the percent of workers that have at
14 least one, and a very large percentage have
15 more than four, samples per year is large.

16 So -- and you folks, of course,
17 make your own judgments on whether that is
18 large enough. But what the purpose of this
19 table is -- to show, at least by year, there
20 is a lot of bioassay data. It's all in
21 milligrams per liter.

22 So that's the only message I

1 wanted to leave regarding Attachment A. And
2 we have other important attachments --

3 CHAIR CLAWSON: John, I just need
4 a clarification on one thing.

5 On this paper here at the end of
6 this, you've got maximum number of samples per
7 year, per worker, per year, and somebody got
8 229?

9 DR. MAURO: Yes, I circled that.

10 Bob Barton, are you on the line?

11 MR. BARTON: Yes, sir, right here.

12 DR. MAURO: Could you help me out
13 a bit? Do you have Attachment A in front of
14 you?

15 MR. BARTON: Yes, I do.

16 DR. MAURO: The far right-hand
17 column called maximum number of samples per
18 worker per year, am I correct in assuming --
19 right now I'm on page eight -- when I see 229,
20 does that mean that there is a worker who in
21 that year had 229 bioassay samples collected?

22 MR. BARTON: Yes.

1 DR. MAURO: Thank you.

2 MR. MORRIS: Can I follow up on
3 that?

4 DR. MAURO: Yes.

5 MR. MORRIS: If that person was in
6 one of your subgroups, you would probably
7 identify that person as having a significant
8 intake during the year. That's the only
9 reason to sample that often.

10 DR. MAURO: I just wanted to make
11 sure on that one.

12 MEMBER ZIEMER: That's virtually
13 every working day.

14 DR. MAURO: Yes.

15 DR. NETON: I have another point
16 I'd like to bring up about the coworker -- the
17 coworker model -- is that we make no overt
18 attempt to strip out all the incident samples
19 that are in there, which tends to bias the
20 upper end on the high side, because unless it
21 is something really obvious like, you know,
22 three milligrams per liter where it is just

1 physically impossible, they are left intact.

2 So all those samples are -- and we
3 are assuming that those are chronic exposures
4 because of the chronic exposure model.

5 MR. MORRIS: Now had that person
6 been in the subgroup that you have picked as
7 an analysis category, there is no doubt that
8 person would have biased your subgroup.

9 DR. NETON: Yes, I suspect there
10 is a pain curve that shows up later here. It
11 was probably an incident. Those are all from
12 one guy.

13 DR. MAURO: See, one of the
14 problems with the program that's -- with the
15 sampling plan is -- let's say we go in and say
16 okay, we want to test this. The coworker
17 model is claiming him. And we happen to pick
18 this guy as being -- well, we're going to go
19 in and pick a guy, and we have data on him.
20 And we reconstruct his dose.

21 And we say, how does that dose
22 stack up against the coworker model? And we

1 know what is going to happen -- exactly, he's
2 going to come in much higher. That's one of
3 the fundamental weaknesses in the sampling
4 plan.

5 That is, the people that we pick -
6 - you're going to see -- we're going to get to
7 a point in this process where we'll say, well,
8 who are we going to pick to determine whether
9 or not this coworker model is claimant-
10 favorable and can be used as, you know -- and
11 we're going to talk about that.

12 And the point you make is very
13 well taken. You could very well walk away
14 after the sampling plan. We randomly sampled.
15 And we're going to show you how we think you
16 could randomly sample to see if there are any
17 surprises.

18 You may very well come out with a
19 positive -- a result that says the coworker
20 model would underestimate this person's dose
21 by a factor of two or three or four if it was
22 used. But then you would say well, wait a

1 minute, we have -- we wouldn't use the
2 coworker model.

3 DR. NETON: Exactly. That's a
4 circular logic there.

5 DR. MAURO: What do we do?

6 DR. NETON: The model is wrong
7 because it doesn't account for the people who
8 have bioassay data.

9 DR. MAURO: I'm going to let the
10 work group, you know, make these judgments.
11 We went through a -- you have to understand,
12 we went through a process saying let's create
13 a compendium of data. So understand what
14 we're looking at. And you now go -- how many
15 bioassay samples do we have by quarter?

16 Let's move on. I think you
17 understand. I fully understand what you're
18 saying and I want to completely -- I want to
19 make it very clear, you know, what the
20 strengths and limitations are on the thing
21 that we are just talking about.

22 But right now all I'm doing is

1 communicating factual information. I'm not
2 drawing any conclusions. I'm trying not to.

3 You will see, if you move on --

4 MR. ROLFES: John?

5 DR. MAURO: Yes.

6 MR. ROLFES: Also to make another
7 comment about the years 1952 and '53, you
8 pointed out workers with no samples during
9 that year and that year only.

10 DR. MAURO: Right.

11 MR. ROLFES: Keep in mind also
12 that there is a lot of construction activities
13 ongoing. And not all the plants are operating
14 at this time. So there are a lot of employees
15 that are building new buildings, not working
16 in radiologically-controlled areas. So there
17 is a reason that many of them aren't sampled
18 as well.

19 DR. MAURO: What happens is --
20 when we get past those tables and go to page
21 16 -- and in fact that's your roll-up by time
22 -- here's the numbers of samples -- here's the

1 number of workers, here's the number of
2 bioassay samples by quarter, and then the
3 workers by quarter, and what the percent of
4 workers that have at least one, two, three,
5 four, or more than four bioassay samples in
6 that particular time period.

7 And the story that emerges from
8 this is that almost -- over 90 percent of the
9 workers have at least one, and 25 percent or
10 more have more than four bioassay samples each
11 quarter -- I'm sorry -- each year. Not each
12 quarter, each year.

13 Starting with page 17, is a -- and
14 I don't want to spend a lot of time on these
15 graphs because they basically tell the same
16 story that I just did, but in a graphical way.

17 So you could look at it and
18 quickly get a picture of -- one that's
19 especially useful, just to get a quick
20 snapshot, is go to page 18. There is a graph.
21 And it's got a blue color line and a red color
22 line. And this is the number of -- we're

1 comparing the number of unique social security
2 numbers, which is the blue line, against the
3 number of -- the people that have bioassay
4 samples.

5 And you can see up through 1980,
6 just about everybody has at least some
7 bioassay samples. They track each other.
8 This confirms the statements that you folks
9 have been making.

10 Now, you do see a deviation -- as
11 you go past 1985 -- where the number of
12 workers on site versus the number of workers
13 with bioassay samples, it looks like about 50
14 percent. Now in my opinion, that means --
15 okay, half the workers, for some reason, were
16 not bioassayed in those years, but half were.

17 The question becomes, is it
18 possible some of the workers that were not
19 bioassayed could have been workers that had
20 higher exposures than the workers that weren't
21 bioassayed? This is a question someone could
22 reasonably ask.

1 DR. NETON: I can answer that
2 question. Starting in 1989, only workers who
3 had the potential to see 100-millirem
4 exposures were required to be monitored per
5 the change in the regulations. So they were
6 very well vetted and considered to be on the
7 bioassay program or not.

8 And people who worked on what was
9 called the clean side were certainly not
10 monitored. People who worked -- were
11 frequently in the process area -- let's say I
12 have the potential to receive 100 millirems --
13 and that was based on an analysis of their --

14 DR. MAURO: So a policy change
15 occurred.

16 DR. NETON: It was a regulatory
17 change.

18 DR. MAURO: A regulatory change.

19 DR. NETON: 54(a)(35), 54(a)(11)
20 was issued.

21 MEMBER GRIFFON: How that was
22 implemented is a question at several sites.

1 DR. NETON: I know exactly how it
2 was implemented because that's when I started
3 working there.

4 DR. MAURO: Okay. And before that
5 -- you can see before that, before 1980, it
6 looked like the policy was, everybody gets a
7 bioassay sample.

8 DR. NETON: There were no
9 controls. I mean out back, no controls. The
10 areas were not cordoned off, the radiological
11 areas, as well as they were after the change
12 in the regulations when you had posted
13 regulatory areas, restricted areas.

14 MR. ROLFES: Also keep in mind,
15 John, that -- the SEC class that we evaluated
16 was for the years of 1951 through 1989. So if
17 we're having an SEC discussion, really what
18 happens after '89 is, you know, for a site
19 profile -- it's technically a site profile
20 issue. So I want to point that out.

21 DR. MAURO: We haven't gotten
22 there.

1 I'm not going to -- it goes on for
2 several pages of graphs. The recurring theme
3 is, a lot of people have bioassay samples.

4 Let's move on to -- we've got two
5 more points to make and then we're going to be
6 ready to discuss this.

7 Let's go to page 23. It's an
8 important page. This is where we start to
9 talk about whether or not it makes sense to do
10 any sampling. And taking into consideration
11 the things we've discussed.

12 On page 23, what we say is okay,
13 if there is any -- I'd like you to -- put your
14 finger also on page 31. So open up to page 23
15 but also put your finger -- sorry.

16 PARTICIPANT: This is a test,
17 right? Dexterity?

18 DR. MAURO: Let's just stick with
19 23 right now. Stay with me. On page 23, what
20 we did is say listen, if there's any weakness
21 in your coworker model, it has to do with --
22 we know that you've rolled up all different

1 workers and we know you've rolled up all the
2 different job categories.

3 And what you didn't look at, are
4 there groups -- the question is are there
5 groups of workers that have bioassay -- have
6 intakes of uranium that are substantially
7 higher than the intakes that would be
8 represented by a quartile, notwithstanding the
9 fact that they probably don't exist because
10 you are claiming that 90 percent -- and it's
11 true -- 90 percent of the workers.

12 I'm going to leave -- I want to
13 put that aside for a minute. I'm looking at
14 this as a purist, saying -- listen, how do we
15 find out if there are groups of workers that
16 either had job functions or worked in
17 buildings at given periods of time where they
18 may very well be different than your coworker
19 model. Their data shows they are different
20 than the numbers you've picked.

21 This table starting on page 23
22 tries to answer that question. Let me tell

1 you what you're looking at. In that table,
2 you'll see -- the very upper left-hand corner,
3 it says 1953 and it says Building No. 1. So
4 this is the first time we're looking at a
5 little more granularity.

6 We were able to go into the
7 database -- and we have the folks on the line
8 that did the heavy lifting and they could give
9 you a little bit more of how this was done --
10 but we were able to go in and start sorting on
11 the data in a way where we could say, oh, no,
12 we could actually go in and pull from the
13 database the bioassay records for workers that
14 worked in Building No. 1 in 1953, et cetera,
15 Building 2, Building 3, '54, '55, '56.

16 And we could stop to ask ourselves
17 the question -- and we could look at their
18 data and say, is there anything about the
19 parameters that characterize the worker
20 population in that strata that says it might
21 be different than the overall coworker model.

22 The number 181 is simply the ratio

1 of the doses to the workers in that strata --

2 DR. NETON: Intakes or doses?

3 DR. MAURO: This is excretion.

4 Okay.

5 DR. NETON: Excretion or intake?

6 DR. MAURO: Samples, sorry, yes,
7 it's samples. It's bioassay samples.

8 DR. NETON: So it's the 50th
9 percentile of what?

10 DR. MAURO: Of the --

11 DR. NETON: Excretion?

12 DR. MAURO: Picocuries per day in
13 urine. Bob, do I have that right?

14 MR. BARTON: I'm sorry, John. Can
15 you repeat the question?

16 DR. MAURO: Yes. A new question
17 was asked, and I think I have the answer but
18 I'd like you to confirm.

19 In Attachment B, page 23, we have
20 numbers -- it says, for example, 181 -- do you
21 see that one in the upper left-hand corner --
22 the very first number that is shaded?

1 MR. BARTON: Yes.

2 DR. MAURO: Okay. That's a ratio
3 of -- that is an expression of the excretion
4 rate of uranium in that group of workers for
5 that -- Building 1, 1953 -- the median for
6 that group versus the median or the 50th
7 percentile for the excretion rate in the
8 coworker model.

9 MR. BARTON: I believe that's
10 correct, John. I really think that Harry
11 Chmelynski took the lead in compiling this.

12 DR. MAURO: We're going to move
13 on, but somewhere along the line, he needs to
14 confirm that as a fact -- not intake but
15 excretion. I guess that is the question.

16 MR. CHMELYNSKI: Yes, these are
17 excretion rates, John. This is Harry
18 Chmelynski.

19 DR. MAURO: Thank you. Okay, got
20 you. So, okay, what we're saying is the 50
21 percent -- it turns out -- let's put that --
22 1953, Building One -- what we're saying here

1 is 32 urine samples were collected. See that
2 thing in parentheses below the 181? And there
3 were 13 workers.

4 So we're saying okay, well, we
5 could pull data on 13 workers. We know there
6 were 32 urine samples taken in that year from
7 workers in that building. And it turns out
8 the median excretion rate in the urine for
9 those workers was 1.8 times higher than the
10 excretion rate associated with your coworker
11 model.

12 So we started to say, you know,
13 are there places -- are there buildings and
14 years -- where that subgroup had excretion
15 rates, the medians, which are substantially
16 higher than the ones in the coworker model?
17 And the answer is, well, here are some. And
18 we use substantially a factor of 1.5.

19 So any place where that ratio --
20 the number in that table is more than 150, we
21 colored it. So you can start to get a feel
22 where okay, it looks like in this building in

1 this year things were -- exposures were
2 somewhat higher -- excretion rates were
3 somewhat higher than what the coworker model
4 would capture.

5 Stay with me. I'm not drawing any
6 conclusions. Just giving a factual piece of
7 information.

8 Paul?

9 MEMBER ZIEMER: Is it 181? Or
10 1.81?

11 DR. MAURO: It's 181 percent.

12 MEMBER ZIEMER: 181 percent, okay.
13 I got you.

14 DR. MAURO: Harry, why did you do
15 that?

16 (Laughter.)

17 MR. CHMELYNSKI: I hate decimal
18 numbers.

19 DR. MAURO: It's 1.81, okay.

20 MEMBER ZIEMER: Got you.

21 DR. MAURO: All right. Now, all
22 right, so what do we have here? It goes on

1 for several tables. All right --

2 DR. NETON: I had a question on
3 that.

4 DR. MAURO: Okay.

5 DR. NETON: When you had quarterly
6 data, '53 had only annual data. When you get
7 down to the years where you had quarterly
8 information, how did you compare the quarterly
9 values to your annual values?

10 DR. MAURO: Harry, you rolled
11 those up. Harry, please?

12 MR. CHMELYNSKI: Yes, this is
13 compared to an average of the quarterlies in
14 Table 2-1 of our report, which --

15 DR. NETON: So you took an average
16 of the quarterly values and compared it to the
17 median value of all --

18 DR. MAURO: The median -- yes, the
19 average -- you've got median values and I
20 guess you took that --

21 MR. CHMELYNSKI: Yes, the average
22 median --

1 DR. MAURO: The average median.

2 MR. CHMELYNSKI: -- in the
3 denominator.

4 DR. NETON: I'm not sure why
5 that's a good comparison but --

6 DR. MAURO: Well, that's what we
7 did. The point is to understand what we did.
8 You know, we took the average of the medians
9 when they are quarterly and compared it to the
10 --

11 DR. NETON: Well, why wouldn't it
12 be a better comparison to compare the
13 quarterlies?

14 DR. MAURO: Well, we don't have
15 quarterlies. We're not at that level of
16 resolution here. In other words, when we
17 grouped them by building, we could not go to
18 quarterly. There just wasn't enough data.

19 And so we had to work --

20 DR. NETON: So you compared the
21 average of the medians against the median of
22 all the values?

1 DR. MAURO: As an indicator --
2 granted that there might be better ways of
3 doing it --

4 DR. NETON: And I'm not sure how
5 that works. Okay.

6 DR. MAURO: Think of it like this.
7 This is an index of all their buildings and
8 time periods where there is some indication
9 that perhaps -- at least in those time periods
10 in those buildings -- the excretion rates for
11 the workers might be somewhat higher than what
12 your coworker model would assign to them.
13 That's all it is. An indicator.

14 DR. NETON: Yes, that's not
15 surprising.

16 MR. ROLFES: Once again, we have
17 to also keep in mind that there could be
18 additional data in that individual's file for
19 the next year or for the next quarter --

20 DR. MAURO: Right, yes.

21 MR. ROLFES: -- which would have
22 to be considered.

1 DR. MAURO: We're getting there.
2 We're getting there. One thing to keep in
3 mind is that the threshold of comparison was
4 set at 1.5, 150. You know, any threshold that
5 you set like that is going to have some
6 element or arbitrariness but, you know, it's
7 a fairly high threshold. It wasn't like ten
8 percent or 20 percent more.

9 So I think it will give you an
10 approximate idea of where or which class there
11 might be some issues in terms of comparing it
12 to the median, rather than as some kind of
13 absolute indications of a big problem.

14 It's designed to map out which
15 class you might pay attention to, in terms of
16 your coworker model, not being claimant-
17 favorable.

18 DR. NETON: Okay. It's no great
19 earth-shaking surprise that this heterogeneous
20 population of workers, based on where Plant
21 One was -- a uranium refinery. So you'd
22 expect higher samples.

1 DR. MAURO: You see what we're
2 doing is, we're collecting information and
3 sorting them in a way that allows everyone to
4 get a bird's eye view of what do we have. And
5 let it speak to us. And let it tell us
6 whether or not there is anything that is
7 surprising? Is there a need to go further
8 from here? Are we done? Or is there some
9 sampling, some different kinds of things we
10 could do?

11 But a lot -- in other words, there
12 is a lot of information here that could start
13 to lead you down a path of -- where do we go
14 from here. We're not done, okay.

15 MR. MORRIS: Can I -- are you
16 going to clarify for us -- what would
17 randomness itself have done? Has there been
18 100 percent uniformity? No differences in any
19 plant? We would have still gotten some --

20 DR. MAURO: You would expect half
21 of them to be higher and half of them to be
22 lower.

1 MR. MORRIS: Right.

2 DR. MAURO: No doubt. The idea
3 being, though, are there any places where --
4 if there is any place where you are -- say,
5 hmm, it looks like, for example, in 1956 in
6 Plant No. 2, the median excretion rate was 2.5
7 times higher than what it would have been
8 assigned to those workers in that --

9 MR. MORRIS: And is that
10 statistically surprising? That's my question.
11 How would you even judge if that would
12 surprise you or not?

13 DR. MAURO: Well, I'm not making a
14 judgment. I'm not trying to make a
15 statistical statement at this point in the
16 process. All I'm trying to do is start to
17 identify pointers that might lead us in a
18 direction that could be helpful to us in the
19 end.

20 MR. MAKHIJANI: Let me give some
21 perspective on what this paper is about, you
22 know, in light of the kind of comment. This

1 paper is not the end result of having analyzed
2 this coworker model according to a sampling
3 plan.

4 These were simply exercises to
5 present some idea of job types and plant
6 placements of workers, to provide the working
7 group with a framework for a sampling plan
8 that we would carry out and what you might
9 expect at the end of it.

10 So this isn't to be judged as some
11 kind of conclusion that SC&A made about the
12 validity of the coworker model or whether you
13 can or cannot do those things.

14 It's simply a response to the
15 working group's direction -- or at least what
16 we understood to be the working group's
17 direction -- as to whether they wanted to go
18 there and have an analysis of this step.

19 DR. MAURO: Just to keep that in
20 mind. So that's the purpose of this paper.

21 MR. ROLFES: Another clarification
22 I just want to point out as well. Our

1 coworker model does not selectively choose
2 what plant the individual worked in. We
3 consider all data for that given year.

4 For example, for 1956, Plants 1,
5 3, 4, 5, 6, 7, 8, and 9 were all lower than
6 the 50th percentile -- the excretion rates
7 were all lower than the 50th percentile.

8 The only one that exceeded it was
9 Plant 2. Our coworker model uses all plants.
10 So we have much more data that indicate lower
11 than 50th percentile excretion rates.

12 DR. MAURO: And in this table -- I
13 mean that's what is useful about Attachment B.
14 It shows you which years and what plants were
15 less than 100.

16 DR. NETON: Let John finish. I
17 mean, I think he's got a good point. Go
18 ahead, John.

19 DR. MAURO: Okay. Now, one more
20 time. Go to page 25. The last question we
21 asked ourselves, you know, by now, what did we
22 do? We started to get a sense for how

1 different it was in different buildings, as
2 compared to the coworker model, which was a
3 roll-up across buildings.

4 And we see that yes, it looks like
5 in some years in some buildings the excretion
6 rates, at least for that year and that
7 building, might have been a factor of two
8 higher, on that order.

9 And I'm not going to draw a
10 conclusion but my inclination is --I'm not all
11 that surprised, you know, given that year and
12 that building, it's a factor two high. It's
13 not a factor of 100 higher. It's a factor of
14 two higher.

15 And here's where judgments comes
16 in. You know that's one of the things I want
17 to show you.

18 We did one more thing that was
19 important. Go to page 25. It turns out we
20 were able to go into the HIS-20 database and
21 sample by job title. It turns out there are
22 a lot of job titles.

1 But what we were able to do,
2 you'll see on page 25, we were able to sort on
3 the job titles. We have 26 job titles here
4 where we have been able to pull data. And,
5 for example, the millman, I'm not quite sure
6 what a millman does --

7 DR. NETON: A mill operator?

8 DR. MAURO: -- a millman. Then
9 there's a chem helper. The number one -- what
10 we found out is that while we were able to get
11 133 samples -- and this crosses all buildings
12 and it crosses all years -- remember we were
13 not able to get a high level of resolution
14 here, so we did what we could with the data
15 that was there.

16 And we said well, if we go in and
17 sample millmen in the database, we were able
18 to get 133 samples. And we found out what the
19 microgram per day excretion rate is: 110. So
20 we now know, or at least we have an indicator
21 of which categories of workers had the highest
22 potential for exposure. And we're looking at

1 it in order, from high to low.

2 And that -- the work category
3 called millman -- it turns out that excretion
4 rate is well above, you know, any of the -- I
5 think just about all of the default excretion
6 rates, in terms of micrograms per day. I
7 think there may be one number that's higher --
8 a few numbers. In other words, that's up
9 here.

10 In other words, this 84th
11 percentile -- if you look at the 84th
12 percentile for the millman, then you look at
13 the 84th percentile in your coworker data set
14 or excretion rate, you find that that's pretty
15 -- that's up there.

16 A good way to do it is to go back
17 to the page that gives you, you know, the
18 excretion rate upon which your coworker is
19 based -- model is based. And we discuss it.
20 The text talks about it.

21 And the one tab that is -- sort of
22 up there. It's higher than most of the

1 excretion rates that you report at the 84th
2 percentile in the different quarters, okay?

3 DR. NETON: Now again, you got to
4 keep in mind that 84th percentile excretion
5 rate has a default minimum of a GSD of 3.

6 DR. MAURO: Right.

7 DR. NETON: So if you calculate
8 some GSD that's less than 3 and imputed at the
9 84th percentile, you're going to be low, from
10 what we would use.

11 MR. MAKHIJANI: Actually the
12 problem that John is describing with the
13 reverse effect. That there are samples that
14 are higher than your artificially high 84th
15 percentile.

16 DR. MAURO: Right. So what do we
17 have? I mean, we're done. What do we have?
18 What we have here is, we've identified time
19 periods and buildings and job categories where
20 the excretion rates for those groups of
21 workers were somewhat higher. In some cases
22 a factor of two, maybe a factor of three

1 higher, than the corresponding time period in
2 your coworker model. All right?

3 If we're going to design -- now
4 here's where we get to the nub of the matter -
5 - would it be productive to go in and say
6 okay, let's randomly sample from the category
7 called millman, a trend where we just go in
8 and randomly pick workers, millman, chemical
9 helper, painter.

10 Let's randomly go in and go back
11 to the earlier tables where we had -- the ones
12 with the shaded areas which showed which years
13 -- let's randomly go in and pick some of those
14 workers in whatever those years were that had
15 more than a factor of two and randomly look at
16 some of those.

17 Grab those workers. Let's
18 reconstruct their doses using their data,
19 using their data, and see what we come up
20 with. Okay?

21 Now, what's going to happen when
22 we're done? Some of them are going to be a

1 little bit higher and some of them are going
2 to be a little bit lower than your coworker
3 model would assign to them. You would expect
4 that.

5 DR. NETON: Five percent of the
6 time.

7 DR. MAURO: Yes.

8 DR. NETON: Well, randomly five
9 percent of the people would be higher, right?

10 DR. MAURO: So now let's say it
11 turns out that when you do that -- when you do
12 that you find that your coworker -- this is
13 the thought problem -- let's say it turns out
14 in a large number of cases when we sample from
15 those subpopulations, we come up with intake
16 rates or doses -- let's say doses, lifetime
17 doses, you know, his working life -- which are
18 substantially higher, factors of three, four,
19 five times higher than would have been
20 assigned to that worker if it turns out he
21 wasn't bioassayed.

22 But he was, of course. But if he

1 wasn't. Now what do we do with that
2 information? Does that mean your coworker
3 model is not protective enough? In other
4 words, biased by using the full distribution.

5 If this guy turned out to be a
6 person that didn't have any data and you were
7 to use the coworker model on him, you would
8 underestimate his dose by this factor.

9 Now, you could argue and say, but
10 no, he does have the data, and we wouldn't do
11 that. Then the question becomes, well, is it
12 possible there might be some millmen -- and is
13 it possible there might be some workers --
14 that worked in that time period that don't
15 have bioassay data, where you would have to do
16 this.

17 And in those cases, you would
18 underestimate that person's dose. This is
19 where -- this is the question that I put
20 before the work group -- whether or not it is
21 worth going through that exercise.

22 I can't see -- now the only other

1 thing we can do, other than that kind of
2 sampling plan and see what it tells us when
3 we're done, is the kind of thing you just
4 described. You know, when you're done, you
5 know it's really not going to tell you very
6 much.

7 What you're saying we should do
8 is, no, let's go find those workers that have
9 no data. And let's see what kind of job they
10 had. Is it possible that some of them worked
11 in this building, too, in that year -- or some
12 of the millmen and we don't have any bioassay
13 data. That might be a more informative piece
14 of work.

15 DR. NETON: Certainly a lot more
16 efficient.

17 DR. MAURO: And a lot more
18 efficient. So what I'm trying to do is the
19 best I can to present to the work group
20 options. Where would you like to go from
21 here, given this information?

22 I think everyone understands what

1 was done and what we have.

2 DR. NETON: I just want to say a
3 couple things before the work group
4 deliberates is -- I can guarantee you that you
5 can go and find dose reconstructions to be
6 done for millmen that have high bioassays that
7 are much higher than this because we have
8 their data. I think that that's probably true
9 that we have most of the data.

10 This is not one of these examples
11 that SC&A likes to point to, I think, of
12 cohort badging or cohort sampling. I think
13 they really did sample the people with the
14 highest potentials for exposures throughout
15 the plant. I think there is a lot of good
16 evidence.

17 Given that, did they miss anybody?
18 We don't think they really did. So then, like
19 you said, you go back and look at the five or
20 seven percent of the people that have zero
21 bioassay data and try to tie those job titles
22 with --

1 DR. MAURO: Job categories.

2 DR. NETON: -- or time periods or
3 whatever and see, if NIOSH reconstructed those
4 doses with the application of the coworker
5 model as we proposed, it potentially
6 underestimates exposure.

7 DR. MAURO: That would be a
8 judgment call. Because you'd have to look --
9 he worked in that building and he had his job
10 category, right off the bat, you would -- see,
11 I would say that you'd have no choice but to
12 use the coworker model. And the evidence is,
13 for that category and in that time period,
14 that's going to underestimate -- you know,
15 that's not going to be a good model.

16 DR. NETON: Right. But what I'm
17 saying is without knowledge that that has
18 actually happened, you know, there's a lot of
19 extra work going on here to pull out and parse
20 out mill operators and chemical operators and
21 say yes, those had higher exposures than the
22 50th percentile of distribution.

1 And I'd say yes, we know. We
2 acknowledge that. I mean that's a given in
3 this model. And then using the 50th
4 percentile, you have to look at the people to
5 which we applied the coworker models. This is
6 will come up in that 50th percentile
7 discussion that we have yet to have, this
8 technical call.

9 Which class of workers do we apply
10 the 50th percentile with the full
11 distribution, not just the 50th percentile?
12 And those workers are picked for that
13 distribution based on a review of the
14 characteristics of their exposures.

15 Oftentimes there are people -- who
16 may have been clerks who had visited the area,
17 walked around and did some inventories. There
18 may have been security guards who did some
19 night walk around. That sort of thing.

20 I would be amazed if we would take
21 a chemical operator who worked six years at
22 Fernald in a very active timeframe and give

1 him a 50th percentile.

2 DR. MAURO: Right.

3 DR. NETON: I can't believe we
4 would do that.

5 DR. MAURO: This is what I was
6 told --

7 DR. NETON: And it is quite
8 possible --

9 DR. MAURO: -- was the answer. To
10 me, if I was sitting on the other side of the
11 table, I would say if I do find some workers
12 that have no bioassay data but they are
13 millworkers, or they worked in this year in
14 that building -- where I know that something
15 is different there than my coworker model --
16 I sure as heck wouldn't give them the full
17 distribution. I may give them the 95th
18 percentile.

19 DR. NETON: Exactly. And I think
20 we do that in a judicious characterization
21 there. But the issue is, you know, it's
22 possible -- I mean we believe that the highest

1 exposed workers were monitored. But we vow it
2 is possible that records could get lost. I
3 mean it's possible we could get a record from
4 a guy that says chemical operator, never been
5 monitored.

6 DR. MAURO: Well, that would
7 certainly raise a flag in our reconstruction.

8 DR. NETON: I'm sorry, Mark, I cut
9 you off.

10 MEMBER GRIFFON: Oh, no, I was
11 just going to ask can I -- can we -- I mean I
12 think that that makes a little more sense
13 actually. But the question I have is -- and
14 I think Mark alluded to this -- how many
15 claims to you have --

16 DR. MAURO: Right.

17 MEMBER GRIFFON: -- with no data.
18 And then if you know that, you must be able to
19 pull those out.

20 MR. ROLFES: Right, yes, you could
21 certainly do an easy query enough. Just enter
22 NIOSH OCAS claims tracking system --

1 MEMBER GRIFFON: And it shows
2 those --

3 MR. ROLFES: -- which I did.

4 MEMBER GRIFFON: Oh, okay.

5 MR. ROLFES: Because John had
6 cited the lung cancers, I queried by cancer
7 type and whether or not the claim was above or
8 below 50 percent probability of causation.

9 By doing that search, I got 16
10 claims that had the lung cancer case that was
11 less than 50 percent probability of causation
12 in dose reconstruction.

13 Furthermore, I went through and
14 looked at job categories and whether or not
15 there were bioassay or any monitoring data.
16 I also looked at the data diagnosis. because
17 the latency can play a large part, as we
18 discussed.

19 In looking at that, there's
20 potentially eight individuals that had less
21 than 50 percentile -- or less than 50 percent
22 probability of causation that had a lung

1 cancer where a coworker intake model could
2 apply.

3 And if you look at some of the job
4 categories and employment durations, some of
5 the individuals were on-site for days, a
6 month. If you look at the job categories,
7 there are absolutely no chemical operators, no
8 millmen --

9 MEMBER GRIFFON: I guess that was
10 my -- that sort of gets to my question. But
11 I'm asking all cases here. But is that -- it
12 seems like that is cumbersome. You had to go
13 to the raw records, right, and look? Or do
14 you -- you can't really query NOCTS, can you?

15 MR. ROLFES: Well, what you would
16 have to do --

17 MEMBER GRIFFON: To find out which
18 claimants have no bioassay data, you have to
19 go through them one by one, right?

20 MR. ROLFES: What you would have
21 to do is query NOCTS for the cases that hit
22 your requirements. If you're looking for, you

1 know, for example, lung cancer cases --

2 MEMBER GRIFFON: No, I'm looking
3 for all cases.

4 MR. ROLFES: Okay. All cases, we
5 have --

6 MEMBER GRIFFON: All claims where
7 they have no bioassay.

8 MR. ROLFES: -- we have 1,040
9 claims total for Fernald. Of those 1,040,
10 we've completed 958 dose reconstructions
11 already. So we've completed greater than 90
12 percent of the dose reconstructions.

13 Of those dose reconstructions
14 completed, 40.4 percent have had a probability
15 of causation greater than 50 percent. So
16 we're quickly limiting the number of -- we've
17 got about 571 claims that have less than 50
18 percent probability of causation. And we've
19 got 16 that are active in dose reconstruction
20 right now.

21 So if you were going to query
22 NOCTS, you would really only want to query say

1 571 -- say 600 claims that have less than 50
2 percent probability of causation.

3 MEMBER ZIEMER: Can you query for
4 whether or not they had bioassay data?

5 MEMBER GRIFFON: That's what I was
6 asking.

7 MR. ROLFES: In NOCTS, what you
8 would have to do is query those 600 cases and
9 then go through them one by one as I did with
10 these --

11 DR. NETON: I think that might be
12 able to be automated more than that, because
13 I know for every SEC evaluation report, we
14 always provide a table of the number of
15 workers with bioassay. And I don't think we
16 go and hand-count those. I think there is a
17 way.

18 MR. ROLFES: Right. It could be
19 possible for ORAU --

20 MEMBER GRIFFON: Because I don't
21 disagree with Jim's point. If we can find
22 those claims, then you look at the job types

1 in there. And then you go back to this kind
2 of system that John is talking about.

3 MR. ROLFES: It might be possible
4 because --

5 MEMBER GRIFFON: If you see a
6 millman in there, then it raises a question.
7 If you see these other jobs, then we have to
8 make an assessment on if your coworker model
9 --

10 DR. NETON: And it is quite
11 possible that in some of those cases, we
12 wouldn't even use coworker model. We could
13 use the efficiency process and if it's not a
14 lung cancer -- and it's, say, a prostate or
15 something -- we could use some very large,
16 overestimated dose that is not even required
17 to get into the coworker arena.

18 MEMBER GRIFFON: I'm just asking
19 just to figure out over the history sort of,
20 who didn't they bioassay? Who didn't have
21 bioassay? Because I don't care about POC at
22 all in this. I just want to know who didn't

1 have records? Who had records? And then what
2 types of jobs are in those ones that didn't
3 have records?

4 DR. NETON: Yes, I agree.

5 MEMBER GRIFFON: And then we can
6 say all right if there's no -- and I expect
7 you are right, Jim, there's no chem operators,
8 there's no, you know -- they did have -- yes,
9 they have them -- and if we find that out, I'd
10 like to see a list of like what job types fall
11 under that category of didn't have any records
12 over their whole course of their being at
13 Fernald.

14 MR. ROLFES: That may be something
15 that is already created. Our dose
16 reconstructors at ORAU -- for every claim that
17 they receive -- they do take all of the data
18 that is received from the Department of
19 Energy, both internal and exposure
20 information, and populate that into a
21 spreadsheet for each individual claim.

22 I don't know if it has, you know,

1 the individual's job title because I'd have to
2 take a look at that. But it may be possible
3 for them to quickly -- they may already have
4 something. I don't know.

5 DR. MAURO: Well, I mean right
6 now, Harry, when you sorted on millmen and you
7 went in, you know, I guess every one that you
8 sorted, by definition, the ones that you were
9 sorting, did that mean that they had to have
10 bioassay data? Or are there some millmen that
11 had no bioassay data?

12 Is there any way -- in other
13 words, when you went into HIS-20, does the
14 fact that you could sort on -- or wherever --
15 where you went in -- I know you worked with
16 multiple data sets. Is it possible for you to
17 go in to see -- are there any millmen that
18 have no bioassay data? Is that something that
19 is trackable?

20 MR. CHMELYNSKI: As far as I know,
21 what you are asking is concerning people who
22 are not in HIS-20.

1 DR. MAURO: Well, I guess that is
2 my question.

3 MR. CHMELYNSKI: Yes, they
4 wouldn't be in HIS-20.

5 DR. MAURO: They wouldn't be
6 there. That's why I asked the question. They
7 wouldn't be there, okay. Thank you.

8 DR. NETON: I think we could go
9 back and look at the database in some way
10 automated -- in an automated fashion and pull
11 out --

12 MEMBER GRIFFON: You mean the
13 NOCTS database?

14 DR. NETON: The NOCTS database.
15 And it actually may be outside of NOCTS.

16 My recollection is that ORAU is
17 coding all the bioassay data. There is a
18 reason. We asked for them to do that early on
19 for future reference because we're developing
20 this huge amount of exposure information. And
21 I was concerned we would lose all that data.
22 So I believe it has been coded into

1 spreadsheets as Mark suggested.

2 MEMBER GRIFFON: I do recall
3 seeing that for individual claim data.

4 DR. NETON: It might not be that
5 difficult to pull out the cases that don't
6 have bioassay. And if it is -- as we suspect
7 or believe -- it's a few in number, let's say
8 1,000 cases, if it's 15, maybe 100, it
9 wouldn't be that onerous to go back and look
10 at those one by one and pull out the job
11 titles.

12 I have some concern about job
13 titles because -- as we've seen at other sites
14 -- they don't always correlate in stepwise
15 fashion with what the person is doing.
16 Oftentimes, human resources is lax in changing
17 things.

18 But it would certainly give us an
19 idea.

20 DR. MAURO: Well, there are lots.
21 They're not just here.

22 DR. NETON: And they are not

1 uniform either.

2 DR. MAURO: We know, for example,
3 in 1957, 2.4 percent of the 4,000 workers did
4 not have any bioassay data. So it doesn't --

5 MEMBER ZIEMER: But only for that
6 year.

7 DR. MAURO: Exactly, only for that
8 year.

9 DR. NETON: And that's another
10 part of the issue. But, again, I would also
11 question in some ways -- were all the workers
12 who were listed as working in Plant 1 really
13 working Plant 1 in that year -- because we
14 know that human resources can kind of lag
15 behind. And if it is a matter of the
16 supervisor saying, this guy is on loan over at
17 Plant 5 -- I'm not saying it's wrong. I'm
18 just saying that there is some opportunities
19 for disconnects there.

20 MS. BALDRIDGE: I have a question.

21 MR. KATZ: Hello. Who is this
22 speaking? Sandra?

1 MS. BALDRIDGE: Yes. You know
2 most workers, you're talking about the
3 bioassay samples, but that only demonstrated
4 a brief window. If they were -- had four
5 pieces of data for the year, that's only four
6 brief windows out of, you know, an entire
7 period of time.

8 Were there any correlation made as
9 to whether those samples represent the
10 exposures during the high or low emission
11 periods based on the MAC levels that are
12 presented in the historical plant documents?

13 DR. NETON: Okay, Bonnie? Is it
14 Bonnie?

15 MR. KATZ: Sandra.

16 DR. NETON: Okay, Sandra. I'm
17 thinking of my other working group. Sandra,
18 this is Jim Neton. I think we might have
19 talked about this before.

20 The way we use bioassay data is if
21 a person had a sample today that has X amount
22 of uranium in it, we would actually do a

1 calculation to determine what's the maximum
2 amount they could have had since their last
3 sample and still be excreting that amount in
4 their urine today.

5 And we would assume that that
6 exposure occurred during the entire duration
7 between the last sample and the current
8 sample. In other words, it's kind of a
9 bounding estimate that we would use as a
10 chronic exposure estimate.

11 MS. BALDRIDGE: But there are
12 periods of time between those samples that
13 could have occurred with these high MACs --

14 DR. NETON: Right.

15 MS. BALDRIDGE: -- if they were
16 not -- if their sample was not given at the
17 appropriate time --

18 DR. NETON: Well, the uranium --

19 MS. BALDRIDGE: -- based on the
20 exposure.

21 DR. NETON: -- the uranium has the
22 property of being excreted over a long period

1 of time. And we know how that excretion
2 behaves. And we can model that and do a very
3 reasonable prediction of what that intake --
4 what the maximum intake could have been in a
5 person only excreting a certain amount on the
6 day they were sampled.

7 MS. BALDRIDGE: And we get back to
8 the excretion --

9 DR. NETON: Right.

10 MS. BALDRIDGE: -- issue --

11 DR. NETON: Yes.

12 MS. BALDRIDGE: -- which I've
13 brought up before. You know if you don't know
14 who had renal damage, you can't know that
15 their excretion rate was 100 percent.

16 DR. NETON: Right. At the levels
17 we're discussing here, at least on the model
18 that we're talking about, these were not
19 sufficiently high to cause renal damage at
20 least in our opinion.

21 MS. BALDRIDGE: But all the
22 workers who possibly had renal damage have not

1 been identified to know whose records
2 represent the 100 percent excretion and whose
3 records potentially show lesser levels of
4 excretion.

5 MR. ROLFES: I think we did
6 discuss this, Sandra. This is Mark. And I
7 believe we did discuss that. And I believe
8 Hans Behling had prepared a white paper and
9 cited a few references as well.

10 And I believe we did discuss that
11 in pretty much detail. And I think we came to
12 resolution on that issue.

13 DR. MAURO: Yes. And I read the
14 transcripts last night. We spent quite a bit
15 of time reviewing the literature on that,
16 reviewing autopsy data. And the outcome of
17 that was that this issue has been put to bed.
18 That it is not going to affect the ability to
19 reconstruct these doses.

20 CHAIR CLAWSON: I've got a
21 question, Jim, you're saying that the uranium
22 stays in your body and is excreted. How long

1 is safe?

2 DR. NETON: Well, it depends on --
3 if you inhale it, it depends on how soluble it
4 is in your lung. And the way we work it is we
5 would pick the most claimant-favorable
6 solubility class.

7 For example, if it is in your lung
8 and we're trying to irradiate the lung, we're
9 going to assume it stayed there for a very
10 long time to radiate the lung and give you the
11 most dose.

12 If it is a systemic organ like a
13 kidney or a liver, we often times would assume
14 that it would just leave the lung, concentrate
15 in the kidney, and deliver that dose. So the
16 amount of time it stays is dependent upon the
17 type of material.

18 CHAIR CLAWSON: Well, if you had
19 it in '57, if you had a urine sample in '57,
20 a small amount of uranium, would you still see
21 it in '58 if you hadn't had any bioassay?

22 DR. NETON: Well, there's a --

1 maybe. It might be below the detection limit.

2 And that's another concept that we use.

3 We would take the detection limit
4 of the system and say well, we don't know what
5 it was. It could be below that but we'll
6 assume that it is equal to the detection
7 limit. Or half the detection limit, I've
8 forgotten how we exactly modeled it. But
9 we'll acknowledge that you can't see zero.

10 And so we'll say well, we don't
11 know what it was but it certainly --

12 DR. MAURO: Wasn't more than this.

13 DR. NETON: -- it is not more than
14 this value, this bounding value that we would
15 use based on the detection limit sampling
16 technique that was used.

17 There's a pretty sort of standard
18 health physics type of calculations. There's
19 nothing exotic that NIOSH has invented here.
20 This is a --

21 MR. ROLFES: Even for a sample
22 that's collected, you know, this is a little

1 elaborate -- even a sample that's collected
2 say 50 years after an intake potentially
3 occurred, I mean this is pushing it but if you
4 have an intake -- you know, back in 1950 and
5 you have a bioassay sample that's collected
6 out here in year 2000, for example, it's
7 pushing it and it's going to be highly
8 uncertain but this can be indicative of an
9 exposure that was incurred 50 years ago.

10 And what we would do, we would
11 interpret this result -- and you can get a
12 huge intake, you know, going back here -- the
13 more data you have, the better you are able to
14 refine that.

15 MEMBER GRIFFON: Would you
16 actually do that?

17 DR. NETON: It would be more of a
18 chronic --

19 MEMBER GRIFFON: A chronic, right,
20 yes. I'm not sure that you would always -- if
21 you have them one day apart, would you tend to
22 --

1 DR. NETON: I think if it was a
2 chemical operator, we would.

3 MEMBER GRIFFON: You would? Yes?

4 DR. NETON: It it was a chemical
5 operator, we would probably do that --

6 MEMBER GRIFFON: Because in that
7 case, you're going to be over your coworker
8 model, a lot over your coworker model.

9 DR. NETON: Right. But see if it
10 was a chemical operator or a mill operator, we
11 would do that. If it were a secretary and
12 there was a determination bioassay sample, the
13 only sample we had, we either would use a
14 coworker or maybe even the ambient
15 environmental depending on how we could
16 bracket their work environment.

17 MEMBER GRIFFON: So it depends.

18 MR. ROLFES: You would have to
19 consider the facts in each individual claim,
20 on a case-by-case basis.

21 MEMBER GRIFFON: Can we take a
22 break?

1 MEMBER ZIEMER: I was just going
2 to say I don't think that your results here
3 are surprising there, John, I think it is what
4 you would expect in terms of comparing it with
5 coworker model and you've identified some
6 areas where possibly there could be gaps,
7 although maybe unlikely.

8 But it seems to me that what NIOSH
9 has suggested makes sense. Due to the small
10 number of un-sampled people, to go back and
11 characterize that.

12 And if there are, for example,
13 mill workers, and it's hard to imagine that
14 they would work there for years and have no
15 bioassay but, as you say, maybe records would
16 get lost, but even if you had a case like
17 that, you would handle it differently, would
18 you not anyway?

19 DR. NETON: Yes, I would,
20 definitely.

21 MEMBER ZIEMER: But in any event,
22 I think it is probably worth looking at the

1 dataset from that point of view. It seems to
2 be more efficient --

3 DR. MAURO: Yes,

4 MEMBER ZIEMER: -- to go back and
5 characterize it and say are there really gaps
6 there.

7 DR. MAURO: I wish I'd thought of
8 that, yes.

9 MEMBER ZIEMER: Well, and this is
10 helpful to point out that the possibility
11 exists. And in a different situation, might
12 have been very different. But this is a
13 pretty robust dataset to start with.

14 DR. NETON: If you recall, there's
15 a TIB, and I can't remember the number, way
16 back when that we tried to delineate the type
17 of job categories where the exposure may have
18 been more administrative, almost non,
19 intermittent, and then regular. And I'm
20 pretty sure in that regular exposure category
21 would be chemical operators, mill operators,
22 that sort of thing.

1 So that would tip off the dose
2 reconstructor to say well, this guy is in a
3 higher exposure group. And to give him the
4 50th percentile and the full distribution
5 would not not make very good sense.

6 But nonetheless, I think we'll be
7 more than happy to go back and pull out --

8 MEMBER GRIFFON: That's what I was
9 going to say. I was going to suggest a break
10 and come back with an action. But I'll just
11 throw it out. I was going to talk to you on
12 the sideline and see what makes sense.

13 But I mean my idea from this would
14 be for NIOSH to have an action of finding --
15 and I wasn't sure, like John, maybe initially
16 I wasn't sure if it was too onerous to go back
17 and find the cases with no data.

18 But if it is, you know, Jim seems
19 to think that it can be done so --

20 DR. NETON: Yes, Jim did it to us
21 again.

22 (Laughter.)

1 MEMBER GRIFFON: So NIOSH can find
2 the cases with no bioassay data, the claims
3 with no bioassay data across the Board. I'm
4 not saying less than 50, higher -- you know,
5 regardless of POC. I would say look at all
6 the claims and see who has no bioassay data.

7 Even if you used an efficiency
8 method on it, I don't think that matters for
9 right now.

10 DR. NETON: Let's try to quantify
11 --

12 MEMBER GRIFFON: Yes, we want to
13 look and see the analysis. And then to the
14 extent you can, determine jobs and buildings,
15 question mark. I had a question on the
16 building thing because of what you were
17 saying. But what you can find out from that,
18 yes.

19 MR. ROLFES: I don't believe that
20 data would typically be entered into a
21 spreadsheet. And, you know, as I mentioned
22 before, we wouldn't selectively assign intakes

1 based on the plant. It would be an entire
2 year, we would consider all plants, all
3 intakes.

4 MEMBER GRIFFON: No, I understand
5 that. But for what we're looking at, we might
6 want to look at that if it was available. I'm
7 not sure it would be.

8 DR. NETON: And, you know, this
9 may be thinking down the line a bit but once
10 we identify those and get some rudimentary job
11 category information, we might be able to
12 match that against the HIS-20 information
13 because obviously SC&A was successful in
14 pulling out -- well, we pulled out buildings -
15 - and SSNs.

16 So, you know, there might be some
17 ability to cross match these claims.

18 MEMBER GRIFFON: Mark, the reason
19 I raised that is just what you -- and I think
20 it is pretty unlikely. But if you go through
21 this and you find 50 people with no data, and
22 they all worked in Plant 2, you just said

1 earlier that Plant 2 tended to be higher, you
2 know. So that would be sort of telling. I
3 mean that would be a concern.

4 MR. ROLFES: Another interesting
5 thing, since we're mentioning Plant 2 and it
6 appears that there are some years that there
7 are higher excretion rates in Plant 2, keep in
8 mind that many of the employees in Plant 2
9 also worked in 3 because they were, in fact,
10 one plant -- two separate sides of the same
11 plant essentially, the same building.

12 MEMBER GRIFFON: But then I would
13 do -- the follow-up action would be for SC&A
14 to evaluate those people against the coworker
15 model. In other words, is the coworker
16 approach bounding? And there's some -- I
17 think there's some -- well, I mean I think it
18 depends on what you find with jobs and stuff
19 how that analysis is going to go.

20 But some assessment of that
21 outcome, I guess, you know, so if you see, you
22 know, I think this gets a bit subjective maybe

1 but because you are going to have jobs, and
2 you are going to have to say likely based on
3 our knowledge of the site, these -- the
4 coworker model would be bounding. That's a
5 little subjective maybe. But I'm not sure how
6 that analysis goes.

7 But I think the first step is to
8 get this -- I think that makes more sense to
9 me anyway. I don't know what other members --

10 MR. MAKHIJANI: One thing that we
11 might want to hear from Bob or Harry, to my
12 memory -- I didn't do the pulling of the data,
13 Bob and Harry did -- but I think the plant
14 data are only available through 1961.

15 Bob? Harry? Bob?

16 MR. BARTON: Yes, Arjun, this is
17 Bob Barton. The plant data -- it seemed to be
18 a practice to label the bioassay sample with
19 plant number up until about 2/1961. The
20 problem with, you know, searching NOCTS is to
21 get, you know, a subset of claims with no
22 bioassay data, we have no idea what plant they

1 worked in because they don't have any bioassay
2 data. So it is kind of a Catch-22.

3 MEMBER GRIFFON: Okay. So we may
4 not be able to get a plant, yes, yes. But at
5 least we can get the jobs.

6 MEMBER ZIEMER: And that table
7 only went through '69 anyway.

8 DR. MAURO: Yes, that's all we can
9 do.

10 DR. NETON: Well, and remember, we
11 have the CATI -- you know, if it's true,
12 there's a small number of samples on the CATI
13 and we know which buildings did you work in
14 and we go through and develop an exposure --
15 not exposure but a history, job history.

16 I don't know if I'm signing up
17 NIOSH for way too much work.

18 MEMBER GRIFFON: It's probably the
19 case. If it's a small number, then it might
20 be --

21 MR. ROLFES: There's plenty of
22 actions that we've already fulfilled. And I

1 believe we've responded with all the things
2 that we've been previously tasked to do, you
3 know all of the things that have been asked of
4 NIOSH to investigate and evaluate.

5 I believe we've fulfilled all
6 those requirements. We've even, you know,
7 even within the past month, I believe, we've
8 done a pretty good job in keeping up with all
9 the new white papers that have been sent over
10 by SC&A as well.

11 I don't believe we've issued
12 formal responses on all of them but we have
13 prepared responses for those. And are
14 prepared to discuss those.

15 I do want to mention once again
16 that this evaluation report has been with the
17 Board since October 25th of 2006. So we're in
18 -- out past two years now.

19 CHAIR CLAWSON: Gee, that's new
20 news. We understand that, you know, it's real
21 difficult -- you know it's interesting. I sit
22 here and I listen to -- we can do a lot of

1 bounding numbers over here and we can twist
2 them around here. We can do that.

3 But one thing, Mark, I want you
4 always to remember is you've got to look at
5 what the outside people -- the claimants that
6 are looking at this. And a lot of them are
7 under-educated, just like me. And that is
8 that we are getting the best product that we
9 can out to them.

10 NIOSH has done a wonderful job. I
11 think they really work hard at taking care of
12 our issues and so forth like that. And I'm
13 the first one to apologize about the two-year
14 time frame. But it's something that we're
15 trying to get best products.

16 MEMBER GRIFFON: Yes, we want to
17 get it right.

18 MR. ROLFES: I completely agree.
19 I just wanted to point that out because I do,
20 in fact, speak with people and explain this,
21 you know. What's going on? What's the new
22 issue that's coming up?

1 And I do honestly speak with
2 people and have to inform people of what the
3 current things that are being discussed, you
4 know. Questions have come up from claimants.
5 Why are they discussing this again? Didn't
6 they resolve that at the previous meeting?

7 So, you know, I'm trying to be
8 honest with all the claimants that I speak
9 with. And I want to make sure that we're
10 doing our best job that we can to get them a
11 timely answer.

12 So, if we could take a ten-minute
13 break?

14 MR. MORRIS: What will be on the
15 agenda when we reconvene?

16 CHAIR CLAWSON: Recycled uranium.

17 MEMBER GRIFFON: No, no. I don't
18 know if we want to skip over -- while we're on
19 this topic, I would propose we talk about the
20 data completeness and validity. And just see
21 where we stand.

22 I know that NIOSH gave a report.

1 It seems to be all wrapped together. Let's,
2 if we can -- can we finish that conversation?
3 And then move on to the recycled -- that is
4 what I would propose.

5 CHAIR CLAWSON: Yes, we've got to
6 finish this one up. But the next thing that
7 is going to come up is recycled uranium after
8 we get this finished.

9 MR. KATZ: Okay. So everyone on
10 the telephone, we're going to mute the phone
11 for ten minutes. It's about 20 past 11. So
12 at about 11:30, we'll get back going again.

13 (Whereupon, the foregoing matter
14 went off the record at 11:20 a.m.
15 and resumed at 11:38 a.m.)

16 MR. KATZ: This is the Advisory
17 Board of Radiation Worker Health. It is the
18 Fernald Working Group. And we have been on a
19 short break. And we are reconvening now.

20 CHAIR CLAWSON: We appreciate
21 John's report and Jim's and Mark's comments.

22 We need to come to closure on

1 this. And before we can do that, Mark's got
2 some issues he wanted to go over. So I'll
3 turn it over to you.

4 MEMBER GRIFFON: Well, I guess on
5 that topic, I mean my proposal for the
6 actions, that's what I would go with, I guess
7 -- do we have agreement on the action that
8 NIOSH is going to follow up on -- identify the
9 cases with no bioassay data?

10 CHAIR CLAWSON: On the NOCTS
11 system?

12 MEMBER GRIFFON: Yes.

13 CHAIR CLAWSON: Okay.

14 MEMBER GRIFFON: Yes, go back to
15 that. And then, you know, the follow up would
16 be for SC&A to look at those -- most likely
17 we're going to have job information, probably
18 not building information, but whatever we have
19 and --

20 MEMBER ZIEMER: I thought NIOSH is
21 going to follow up on this. Who is going to
22 follow up?

1 MEMBER GRIFFON: NIOSH is going to
2 follow up. And then subsequent to that they
3 are going to produce what I would expect is
4 sort of this listing --

5 MEMBER ZIEMER: Oh, okay.

6 MEMBER GRIFFON: -- and hopefully
7 not that big a number of people and what their
8 jobs were. And then SC&A is got to then look
9 at that and make some assessment of whether
10 the coworker model would be a bounding
11 approach for those workers. That's the next
12 step.

13 And then maybe, you know -- I'm
14 not sure what we're going to get so there may
15 be some subjectiveness to that assessment.
16 But anyway, that's the sort of the two-step
17 process in my mind anyway.

18 DR. MAURO: Just to clarify that a
19 little bit more.

20 MEMBER GRIFFON: Yes.

21 DR. MAURO: Let's say we do find
22 some categories of workers, millmen, that have

1 no bioassay data which brings us to the end of
2 the story. If you don't find any categories
3 of workers that fall in those categories that
4 I had listed, those 26, let's say they all
5 have bioassay data, is that the end of the
6 story? Basically we couldn't find any? I
7 mean that may be the outcome of your
8 investigation. I don't know.

9 DR. NETON: Well, I think it is
10 incumbent upon us maybe to discuss how we
11 would -- how the application of the coworker
12 model would bound the categories that we're
13 looking at.

14 DR. MAURO: Okay.

15 DR. NETON: Yes.

16 DR. MAURO: Because it could be
17 kind of lengthy but, you know, yes.

18 DR. NETON: Is the coworker model
19 appropriate for the people who were using it?
20 I mean that's the bottom line.

21 MEMBER GRIFFON: That's the bottom
22 line. And then SC&A can review that report

1 and that product.

2 MEMBER ZIEMER: Because you could
3 have future claims, I suppose.

4 DR. NETON: Yes, exactly.

5 DR. MAURO: As an SEC issue, okay,
6 if you do run across a person that had a job
7 category that could be a concern and there's
8 no bioassay data, would the solution be pick
9 it off and use the 95th percentile or some
10 other parameter? In other words, it becomes
11 a -- what I'm getting at is do we have
12 tractable route? If we do run into that, is
13 it tractable?

14 And if it is, is it an SEC issue?
15 I mean I know I'm pushing everyone but taking
16 this to its logical conclusion, even if you do
17 run into some cases where gee, this guy didn't
18 have any bioassay data and he had a pretty
19 serious job, what does that do to your ability
20 to reconstruct doses?

21 MR. ROLFES: Let's also consider
22 how is identifying a case where we have a

1 claim that we've completed a dose
2 reconstruction for that had a probability of
3 causation of greater than 50 percent, how
4 would identifying whether or not that case had
5 bioassay data, you know, be of benefit to us?
6 Or to that claim?

7 MEMBER GRIFFON: Well, we're
8 looking at this as a sample that's
9 theoretically representative of the overall
10 population of potential claimants. I know
11 that's the way I'm looking at it.

12 DR. NETON: I could see that
13 logic.

14 MR. ROLFES: Okay. I'm just
15 trying to, you know, make sure that we're
16 doing the appropriate work rather than doing
17 a large effort if we don't need to fully do
18 that.

19 MEMBER GRIFFON: We don't want
20 that.

21 MR. ROLFES: I mean I don't want
22 to waste, you know, time if it's not going to

1 be helpful, you know.

2 DR. NETON: I think the answer to
3 John's question, though, I think is given that
4 we have somewhere in the vicinity of 400,000
5 uranium measurements on workers over a very
6 long period of time, I believe that there is
7 something we can do for any worker who doesn't
8 have bioassay data.

9 I mean there's enough monitoring
10 data for enough subpopulations out there that
11 NIOSH could develop an approach regardless of
12 what was missed.

13 MEMBER GRIFFON: But I think the
14 other thing, from my standpoint anyway, I
15 won't speak for the work group, but, you know,
16 if you look -- you find say 50 cases and you
17 find jobs that I would expect to have some
18 monitoring data, then it raises the question
19 of the completeness of the -- you know.

20 So, you know, likely -- I mean --
21 I think, John, what you are likely to find is,
22 you know, maybe NIOSH will come back and say

1 we found these 50 people and most of them, by
2 job types, we believe they are fully covered
3 by the 50th percentile. There were these two
4 that seemed to have jobs in the chemical
5 operations areas, something like that. We
6 don't know how they got missed over the years.
7 But we would assign the 95th to them. That
8 would be their proposal.

9 And to me, that would probably be,
10 I would come back and say that's reasonable,
11 you know. If they came back with 50 out of 50
12 that ended up in the high category, I'd say
13 wait a second. Something is wrong here.

14 Why were all these people missed
15 over the years? You've got so many samples.
16 Why were all these people missed?

17 MR. ROLFES: Another clarification
18 that I would like to ask is that the number of
19 workers that we have, the 10,040, many of
20 those claimants are also outside of the
21 current SEC period that was evaluated.

22 So if we're concerned about a

1 special exposure cohort perspective versus a
2 dose reconstruction perspective, do we want to
3 include the population of employees that
4 worked that site from 1990 through 2007, you
5 know, 2008? Do we only want to consider this
6 as an SEC issue?

7 MEMBER GRIFFON: That's a valid
8 point. I mean yes.

9 MR. ROLFES: I mean I don't want
10 to do something, you know --

11 MEMBER GRIFFON: Right, you're
12 right, after '89, some people were
13 legitimately taken off. So, you know, things
14 changed again.

15 MR. ROLFES: I don't want to, you
16 know, do a large analysis so that isn't going
17 to be helpful for answering the question that
18 we've been asked to, you know, to --

19 MEMBER GRIFFON: If the petition
20 only went up through '89, then yes.

21 MR. MAKHIJANI: We -- Bob and
22 Harry, correct me if I'm wrong -- I think we

1 only looked until 1989 because of the SEC
2 limitation. And I think these particular job
3 -- Harry, do these particular job categories
4 only go to '89 because after '89, the jobs
5 were different anyway. The decommissioning
6 and all that. You wouldn't have chemical
7 operator -- you wouldn't have all these jobs.

8 MEMBER GRIFFON: Ray has that,
9 yes.

10 MR. BARTON: If I could just add a
11 little clarification to job title, you're
12 right. They did change tremendously.
13 However, in the remediation years, they did
14 recreate the chemical operations folks under
15 this HAZWOPER, you know, titles.

16 But like the maintenance functions
17 basically stayed the same. And, you know,
18 remediating the buildings and tear-down and
19 what have you. But chemical operations did
20 change immensely but they did bring them back.

21 MEMBER GRIFFON: Yes, I mean my
22 opinion would be we should stop this at '89 if

1 that's easy to do. I mean obviously if --
2 well, John, I think if you add people that
3 started before '89 and worked through --

4 DR. MAURO: You would catch them.

5 MEMBER GRIFFON: -- you're going
6 to catch them anyway.

7 MR. MAKHIJANI: If there are no
8 samples up to '89, then they would be -- well,
9 that's why there are no samples.

10 DR. MAURO: But then that might be
11 a problem.

12 MR. ROLFES: Keep in mind, though,
13 if we have bioassay data for that individual
14 in 1990, that would be sufficient in my mind
15 --

16 MEMBER GRIFFON: Well, that's what
17 I was saying -- that's what I was trying to
18 grapple with. So you might end up -- yes --

19 MR. ROLFES: I'm just making sure
20 we put these things on the table so that we do
21 what we're being asked to do and making sure
22 that we're, you know, doing it as efficiently

1 as possible.

2 MEMBER GRIFFON: Yes, I guess our
3 focus would be the SEC period obviously. But
4 if you -- how you present it for each person,
5 you might want to think through that.

6 DR. NETON: Yes, we will think
7 about it and make we do it in a rational
8 manner.

9 CHAIR CLAWSON: I guess I'm
10 looking at what kind of --

11 MEMBER GRIFFON: That was the
12 action, I think, right?

13 CHAIR CLAWSON: Up to '89 but --

14 DR. NETON: At a minimum '89. We
15 may actually do a little more if it looks like
16 --

17 CHAIR CLAWSON: Eliminate
18 carryover.

19 DR. NETON: -- carryover. But
20 certainly the SEC period we will evaluate. It
21 really comes down to can we reconstruct their
22 dose. And if there is something in 1990

1 that's useful, we won't cut it short.

2 MR. ROLFES: Right. There could
3 be people that are beginning employment in
4 '89, you know, may have worked, you know, a
5 few months in training, et cetera, prior to
6 going in for decontamination.

7 DR. NETON: Okay. That would be a
8 good idea. I just want to mention to John,
9 this is a good start on the technical call
10 that we're going to have on this 50th
11 percentile issue. And these are exactly the
12 kind of --

13 DR. MAURO: The conversion issue
14 that I intend to --

15 DR. NETON: This is OTIB.

16 DR. MAURO: The OTIB where we use
17 the 50th percentile, full distribution.
18 That's part of the procedures working group.

19 DR. NETON: Yes, and it is a very
20 similar issue. And a good start for that
21 conversion.

22 MEMBER GRIFFON: Now we have

1 technical calls in the day of our group
2 meetings.

3 CHAIR CLAWSON: So we're clear on
4 what the --

5 MEMBER GRIFFON: Yes. The action
6 for that one, yes.

7 CHAIR CLAWSON: Okay.

8 DR. NETON: I can't give you a
9 completion date right now.

10 CHAIR CLAWSON: I do have one
11 question. Does this sampling plan coming in
12 and so forth like, you guys already came up
13 with the coworker data, the coworker model?

14 DR. NETON: That was developed in
15 2007.

16 CHAIR CLAWSON: Okay. I just
17 wanted to make sure. Okay. It just seemed
18 like all of a sudden I'm trying to stay on
19 focus of where this -- how the sampling plan
20 evolved.

21 DR. NETON: The coworker model
22 surfaced and then --

1 CHAIR CLAWSON: Okay.

2 MEMBER GRIFFON: Well, the other
3 items I had, just to continue from before
4 break, was the question on the validity of the
5 data. And this goes back to the -- and, you
6 know, this has been raised by the petition
7 but, I mean, it's actually part of our
8 Advisory Board procedure now to consider the
9 validity of data.

10 So when you are developing
11 coworker models, you're using HIS-20 data.
12 For years, since there are some new faces
13 around the table, for years workers at the DOE
14 facilities have been concerned that, you know,
15 this database stuff, we don't trust it. We
16 don't believe it.

17 So I've seen, as part of my
18 mission on the Board from year one, you know,
19 to sort of go back and test that. And ask
20 NIOSH to test that. And SC&A to review that.

21 And this means going back to raw
22 data -- you know, as primary data as you can

1 find. A lot of times it is uranalysis
2 logbooks, whatever. And I know that we have
3 a report from NIOSH on that for the HIS-20.

4 DR. MAURO: Correct.

5 MEMBER GRIFFON: I don't think we
6 ever tasked -- and I was talking to John on
7 the way in here but I don't know that we
8 specifically tasked SC&A with reviewing that.
9 And, you know, I know we discussed it at the
10 last work group meeting.

11 But I don't think we ever tasked
12 them and said look through the details of that
13 and give us a report back as to whether you,
14 you know -- so, Mark, just to understand, I
15 was looking at -- and it's actually -- it's on
16 the O: Drive, the millspec report is on there.

17 And actually I think in each tab
18 in the Excel spreadsheet there's a reference
19 ID that gives the document, the logbook, or
20 the urine cards, or whatever they were. I
21 think -- I looked at it quickly just here.

22 So I think everything should be

1 there that SC&A would need to look through it,
2 right?

3 MR. ROLFES: I'm taking a look.

4 MEMBER GRIFFON: I don't think the
5 log -- I don't think the urine logs were
6 posted but I think you referenced them so they
7 can find them in the --

8 MR. ROLFES: Oh, if it's not
9 there, we can find ours --

10 MEMBER GRIFFON: Yes. But I mean
11 I think --

12 MR. ROLFES: -- and get it there.

13 MEMBER GRIFFON: -- you can find
14 them through the cite research database.

15 MR. ROLFES: I believe those were,
16 in fact, put out on the O: Drive. But it's
17 been more than a year that they've been out
18 there.

19 MEMBER GRIFFON: At any rate, they
20 are either well -- I know they are well
21 referenced because I just looked at them -- or
22 they're on the O: Drive under the A/B document

1 review section is where I'm talking about,
2 yes.

3 MR. ROLFES: Correct.

4 MEMBER GRIFFON: So I mean my -- I
5 think that we need to task SC&A with reviewing
6 that report and close that out. You know we
7 haven't -- I thought we did but at any rate,
8 John, you haven't done it yet.

9 DR. MAURO: No, we haven't done
10 it, either way.

11 MEMBER GRIFFON: So either way, I
12 think we need to task that if people are in
13 agreement with that.

14 MR. MORRIS: Another detail you
15 may want to know about is the issue that the
16 coworker study that we've just discussed is
17 now in the process of being turned into an
18 OTIB. So the substance will not change. It
19 will just be a format to make it a formal
20 document.

21 MEMBER GRIFFON: Okay.

22 MR. MORRIS: And I think you've

1 already invested your review time there. So
2 it may be -- may or may not be worth trying to
3 assign that. But it won't be long before that
4 comes out as a formal document.

5 MEMBER GRIFFON: Okay.

6 CHAIR CLAWSON: Which white paper
7 was this one?

8 MR. MORRIS: The recycled -- no,
9 excuse me -- the Coworker Study for Uranium
10 Urine, the topic of the morning.

11 MEMBER GRIFFON: So that would go
12 back to sort of our last action as the
13 coworker review and the coworker model but if
14 it is going to be official now, yes, it's the
15 same thing, the same model.

16 MEMBER ZIEMER: I'd like to ask
17 for clarity, John, when your group does this,
18 you review the report. But what do you do in
19 terms of validation? Are you going back and
20 subsampling?

21 DR. MAURO: Yes. What we would do
22 is we'd go into the hard copy, you know,

1 scanned data that is the source material for
2 HIS-20. And basically what I'm hearing is
3 were the data captured faithfully? And going
4 from whatever the scanned hard copy logbooks,
5 whatever form they were, faithfully
6 transcribed.

7 MEMBER ZIEMER: Yes, I understand
8 that. I understand that. I'm asking, in a
9 sense, to what extent -- you're obviously not
10 going to do 100 percent sampling. And do you
11 guys develop the protocol or do you have an
12 established protocol for how you do that?

13 DR. MAURO: The normal procedure
14 would be I talk to Harry and say Harry, here's
15 the arena. And we need to submit a
16 statistical statement regarding the
17 transcription.

18 MEMBER ZIEMER: Right. I'm trying
19 to get a feel for the extent of the task here.
20 What would be a comparable -- this is a really
21 robust database to start with.

22 DR. MAURO: Yes.

1 MEMBER ZIEMER: And I don't have
2 even a gut feel for what makes sense on at
3 what point you say I've sampled enough or does
4 -- Harry, do you have a kind of statistician's
5 guideline that you use a priori? Obviously we
6 don't want this to be an exercise that fills
7 the time available to do the job or whatever
8 it may be.

9 MR. CHMELYNSKI: The wrong way is
10 to come up with a sample size.

11 MR. KATZ: Harry, can you just
12 start over again? Thanks.

13 MR. CHMELYNSKI: I'm sorry. There
14 are ways to come up with a sample size for
15 validation. I'd have to look more into it.
16 My guess is we're talking about maybe 100
17 cases. That's just off the top of my head.

18 MEMBER GRIFFON: Well, they're
19 look at -- you're looking at data points in
20 the database, right?

21 DR. MAURO: Yes, I was thinking in
22 terms of actual bioassay samples. A case

1 being a person could include hundreds of
2 bioassay samples.

3 MR. CHMELYNSKI: Right.

4 DR. MAURO: I was thinking more
5 along the lines of some kind of cross-section,
6 a nested sampling by time and maybe by -- I
7 guess by building you already have. In other
8 words, we had the HIS-20 data sorted out by
9 year and by building. And by job category.

10 MR. CHMELYNSKI: Right. For a
11 small time window we have that.

12 DR. MAURO: Well, up through '61,
13 correct. So we'd have to somehow develop a
14 sampling plan that I guess could make a
15 statistical statement at the end, you know.

16 Let's say you, just for the sake
17 of argument, you randomly select 100 bioassay
18 samples, some kind of stratified sample. And
19 all together there are a 100 samples.

20 And then we go in and we say okay
21 and we make a table. Here's what's in the
22 hard copy. And right next to it, here's the

1 number in milligrams per liter that's in the
2 HIS-20 database.

3 And let's say we find five of them
4 are wrong. Or one of them wrong. Or none of
5 them wrong. You know quite frankly I'm not
6 sure --

7 MEMBER ZIEMER: Well, there's two
8 parts of it. One is how much do you sample to
9 start with? And number two, what do you do
10 with the results?

11 DR. MAURO: Right.

12 MEMBER ZIEMER: And I think a
13 priori it would be useful -- and not to sort
14 of say well, we'll kind of figure this out as
15 we go -- and have a firm plan, you know, we're
16 going to sample a 100 samples or a 1,000 or
17 whatever it is.

18 DR. MAURO: Right.

19 MEMBER ZIEMER: And we're going to
20 have some criteria, whatever they are. Now it
21 may be that once you get into these, you know
22 we thought this made sense but as we look at

1 it, it's different.

2 And from my point of view, I think
3 for tasking, we need to know what kind of
4 commitment this is in resources because we've
5 got so many things going on now. And we've
6 got to prioritize some things.

7 And I would like to see if we
8 could do it. If Harry can develop -- now, you
9 know, we don't want a big effort on a sampling
10 plan but what is it you are going to do.

11 DR. MAURO: Yes, we don't want to
12 do that again.

13 MEMBER ZIEMER: What it is is a
14 one-pager. You know here's the plan.

15 DR. MAURO: Harry, we need a one-
16 pager by tomorrow. Can you do it?

17 MEMBER GRIFFON: Yes, I mean I
18 don't disagree. I was trying to keep it
19 moving.

20 MEMBER ZIEMER: No, no, I know he
21 has to come back.

22 MEMBER GRIFFON: I agree.

1 MEMBER ZIEMER: The reason I'm
2 suggesting that that be done, that we bounce
3 that off -- I would say bounce it off of Mark,
4 as a minimum, and share it with the group.

5 MEMBER GRIFFON: Yes.

6 MEMBER ZIEMER: And I would like
7 you to take a look at it. We should all look
8 at it and Ted have the availability of the
9 cost information. And maybe we can have this
10 done within the week.

11 And then say proceed then, you
12 know.

13 MEMBER GRIFFON: Right.

14 DR. MAURO: Yes.

15 MEMBER ZIEMER: I don't know what
16 we're talking about here.

17 MEMBER GRIFFON: Yes, I agree.

18 MEMBER ZIEMER: Is this a 100
19 dollar exercise or a 100,000 dollar exercise?
20 Or is it somewhere in between?

21 DR. MAURO: I don't see that --

22 MEMBER ZIEMER: Or do you have the

1 49.95 special this week?

2 (Laughter.)

3 DR. MAURO: To me everything is
4 easy. This sounds easy. But I hate to do
5 that to Harry if it's not. Harry, you know --

6 MEMBER ZIEMER: The statisticians
7 can make it more complex.

8 DR. MAURO: Yes, right.

9 Can you come up with something?

10 MR. CHMELYNSKI: I think you're
11 asking a very standard question. And that
12 there are many, for example, DoD acceptance
13 sampling plans that would work.

14 MEMBER ZIEMER: Let's have some
15 rationale.

16 MR. ROLFES: I think that's what
17 NIOSH used.

18 MEMBER ZIEMER: Yes, you did. The
19 problem is with DoD acceptance plans, they are
20 probably the equivalent to the cost of a
21 toilet seat for the Department of Defense.
22 And so --

1 MEMBER SCHOFIELD: That was 645
2 dollars.

3 (Laughter.)

4 MEMBER ZIEMER: And that's per
5 sample. But if that's agreeable, it's just to
6 sort of put some specificity on your
7 suggestion.

8 MEMBER GRIFFON: Oh, yes, that's
9 fine.

10 MR. MORRIS: It may be that your
11 action will just be to look at what we did and
12 accept it because we used the DoD acceptance
13 sampling plan.

14 MR. ROLFES: I think we explained
15 how it was done and then presented the data.

16 DR. MAURO: I think the example is
17 on the web.

18 MR. ROLFES: Correct.

19 MEMBER ZIEMER: And so maybe they
20 don't have to do that. I don't know. See,
21 that's --

22 MR. MORRIS: We may not need to

1 resample the data and recreate the data
2 collection drill.

3 MEMBER ZIEMER: But they may want
4 to sample your data. I don't know.

5 MEMBER GRIFFON: Well, the other
6 thing I want to know --

7 MEMBER ZIEMER: I don't know what
8 it is they are doing.

9 MEMBER GRIFFON: Just a couple of
10 questions on what you produced. I want to
11 make sure I have the most current version. It
12 looks to me like -- I didn't count all the
13 logbooks but there is a number of them -- 20,
14 25, more than that probably.

15 MR. MORRIS: It's been so long I
16 don't know the details to answer that.

17 MEMBER GRIFFON: Yes. But at any
18 rate, my question was more the -- I think one
19 thing that SC&A might consider when they look
20 at this closer is what are the years covered
21 because I see a lot of them in the '50s and
22 into the '60s. I think I saw one in 1970 --

1 I'm just glancing at it quickly. But, you
2 know, I only saw one in the '70s. So, you
3 know, it's just a question of whether we're
4 covering all time frames.

5 MR. MORRIS: The recollection, I
6 believe, you looked at it previously back in
7 2007 to look a population from each decade.
8 I believe that's what we had, in fact, done.

9 MEMBER GRIFFON: Yes. We did talk
10 about that, yes. And there might just not
11 have been as many books available for some
12 years as others or some decades, you know, but
13 -- because, yes, like I said, it seems to me
14 just glancing at this, it looks like a lot in
15 the '50s, but thin in the '70s. And I don't
16 see any in the '80s yet. But anyway.

17 CHAIR CLAWSON: So --

18 DR. MAURO: My marching orders
19 right now it sounds like let's first take a
20 look at what you folks have put up on the O:
21 Drive related to the sampling that you did,
22 which is a millspec sample. And remember it

1 had a lot of nuance to it. In other words,
2 you looked at it in a lot of different cuts.

3 We could do -- we could certainly
4 read that and see what you did. And I guess,
5 perhaps, using our judgment just check to see
6 if we come to the same place you did regarding
7 the percent of hits. I remember you reported
8 it as well, we got this many spelling errors.
9 I remember you actually caught spelling
10 errors.

11 And in the end, the hits were
12 mostly editorial more than substantive. I
13 remember the discussion -- I read it last
14 night. We could check that work or we can not
15 even look at it and just do our own. I mean -
16 -

17 MEMBER ZIEMER: No, I think we're
18 asking you to check --

19 DR. MAURO: To check their work.

20 MEMBER ZIEMER: -- work and --

21 DR. MAURO: And that's what we'll
22 do.

1 MEMBER ZIEMER: -- and then if you
2 decide that that's sufficient, I think that's
3 the end of it.

4 DR. MAURO: Well, then there's no
5 need for a plan. Then simply --

6 MEMBER ZIEMER: No, if you decide
7 that you don't have to go back and sample
8 anything --

9 DR. MAURO: Yes, we'll look at
10 their work, see what they did, and see if it
11 seems to hold up. There will be a judgment
12 made by our statistician if this looks like a
13 reasonable sample, and we checked --

14 MEMBER ZIEMER: No, I don't think
15 we're asking you to resample.

16 DR. MAURO: Okay, good, good.
17 That makes it straightforward. And we can
18 actually start right now because we know what
19 we have to do.

20 MR. ROLFES: Here -- I'll take a
21 second. I did locate the files that I was
22 referring to. There is a document out on the

1 Advisory Board Review folder. It's dated
2 March 10th, 2008. And the title is Comparison
3 of the FMPC Hard Copy Bioassay Records to the
4 HIS-20 Database.

5 And I'll just read the executive
6 summary for the record here:

7 "Since data extracted from the
8 Canberra HIS-20 database was used in the
9 uranium bioassay coworker study for the feed
10 materials production center at Fernald, the
11 verification for the completeness and accuracy
12 of the data in HIS-20 was desired.

13 An acceptance sampling plan was
14 developed using statistical method known as
15 sampling by attributes. Hard copy records
16 were acquired independently using data capture
17 trips by members of OCAS and the ORAU team.
18 They consist mainly of analytical data sheets,
19 urine request cards, and an annual urinalysis
20 summary report.

21 "For this study, 33 electronic
22 files scanned from hard copy bioassay results

1 were examined. There were eight files which
2 were primarily subcontractor or gross alpha
3 beta results. These files were eliminated
4 since they would not effect the coworker study
5 of FMPC employees for the uranium coworker
6 study.

7 "Twenty of the remaining 25 files
8 met the criteria selected. Five files did not
9 meet the criteria but were unlikely to result
10 in any significant changes to the coworker
11 study if the data missing from HIS-20 were to
12 be included. Overall, 90 percent of the data
13 was matched with only a few files accounting
14 for the majority of the results that were not
15 located in HIS-20."

16 MEMBER ZIEMER: What was the name
17 of that file again? Comparison of --

18 MR. ROLFES: The title was
19 Comparison of FMPC Hard Copy Bioassay Records
20 to the HIS-20 Database Dated March 10th, 2008.

21 MEMBER GRIFFON: Do you have --
22 that was the title. Is that the file name

1 also?

2 MR. ROLFES: That's the title of
3 the document. The file name, however, is
4 fernaldhis20draftfinalanalysisversion2.

5 MEMBER GRIFFON: There it is,
6 okay.

7 MR. ROLFES: And it was added on
8 3/10/2008, just the review file.

9 MEMBER GRIFFON: Thanks.

10 MR. ROLFES: There are also
11 supporting files right next to it in there.
12 I'm pulling it up. There's a couple of Excel
13 spreadsheets in here.

14 MEMBER GRIFFON: And then the
15 urinalysis logbooks available on the O: Drive?

16 MR. ROLFES: I believe those are
17 in here. Let me see if I can find --

18 MEMBER GRIFFON: I'm just asking
19 if they're -- if you sampled from the
20 available ones on the O: Drive? Or if you
21 only posted the ones that you used for the
22 study on the O: Drive?

1 MR. ROLFES: No. Well, any data
2 that we collect would be in the site research
3 database.

4 MEMBER GRIFFON: Right, right.

5 MR. ROLFES: I don't know if we
6 duplicated it in the O: Drive as well.

7 MEMBER GRIFFON: I don't think you
8 did. But that's fine. You've got the
9 references, yes. So there could be more.
10 I'll have to look at the way you sampled but
11 there could be more logbooks.

12 You didn't sample 100 percent of
13 the logs. I think you went --

14 MR. ROLFES: No, I think we
15 discussed in that executive summary the
16 quantity of the files that we sampled.

17 MEMBER GRIFFON: Right, okay.

18 MR. ROLFES: And from looking at
19 within the Advisory Board's review folder
20 under Fernald, I'm looking at Document No.
21 4076 FMPC Uranium Urinalysis Program -- no,
22 nope, that wouldn't be it.

1 I thought maybe we had some of the
2 raw files right there but that's not the
3 correct one. If you want to continue, I
4 thought I'd have the time to open --

5 MEMBER GRIFFON: Yes, I guess what
6 I'm asking is in that executive summary, Mark,
7 it says for this study 33 electronic files
8 scanned hard copy bioassay results were
9 examined. Are there more files on the O:
10 Drive in the site research database than 33?

11 There are other files? Okay. So
12 if we wanted to --

13 MR. ROLFES: Yes, they are
14 available in one place or the other.

15 MEMBER GRIFFON: Right. And you
16 selected those by your methodology?

17 MR. ROLFES: Yes, correct. All
18 the data that we captured has been added to
19 the site research database so it is available
20 either there or on the O: Drive.

21 MEMBER GRIFFON: Okay. So I think
22 that's a pretty clear task, right, John?

1 DR. MAURO: Yes.

2 MEMBER GRIFFON: We'll start with
3 that.

4 DR. MAURO: My guess is Harry will
5 be getting in touch with you to make sure that
6 we're looking at the right data.

7 MR. ROLFES: Okay.

8 DR. MAURO: Harry, are you still
9 on the line?

10 MR. CHMELYNSKI: Yes, I'm here.

11 DR. MAURO: Great. I guess we've
12 got an action item that I think we are going
13 to be looking to you for. I don't know if you
14 heard everything --

15 MR. CHMELYNSKI: Yes.

16 DR. MAURO: -- or have written it
17 down but certainly feel free to call Mark
18 Rolfes to make sure you are looking at the
19 right material. And then when we get back
20 together, we'll regroup and we'll discuss
21 this.

22 MR. CHMELYNSKI: Okay.

1 DR. MAURO: Thank you.

2 MEMBER GRIFFON: So the last item
3 I had was the -- going back to this
4 completeness question. And this -- I mean --
5 and this also is a question on time, Paul, I
6 mean I think -- but we did this with Rocky
7 Flats.

8 It was the question of okay, you
9 are clearly in this site similar to Rocky
10 Flats. You're dealing mostly with individual
11 data. If they have enough data to do their
12 own reconstruction, NIOSH has made that
13 determination.

14 The thing that we'd asked at Rocky
15 Flats was look at a sampling of those -- the
16 claim records and make a judgment on whether
17 the records are sufficient to reconstruct --
18 are they complete enough in other words?

19 And I think in the -- what we
20 found in the Rocky Flats review was that there
21 were some inconsistencies. But overall, there
22 were no systemic -- there were no systemic

1 trends or no problem systemically. So, you
2 know, we judged that overall the records of
3 the claimants would have been complete.

4 And I guess here is where you look
5 at the comparison of okay, we have a chem
6 operator -- and this goes back to -- I don't
7 know where that 1970 thing came from but if
8 you have a chem operator who only worked in
9 the '50s and '60s and you see, you know, that
10 they should have been on yearly urinalysis but
11 they weren't, they have like, you know, two
12 samples in ten years, that would be brought
13 forward.

14 Now one thing like that alone I
15 don't think is going to make a problem, at
16 least in my opinion, but if we start to see a
17 trend, the systemic problem of a lot of things
18 are missing in these claimants' files, then
19 that's where we would have a question about
20 the completeness being sufficient for dose
21 reconstruction.

22 So this is getting away from the

1 coworker model and looking at, you know, are
2 the individual claimants' files good enough to
3 do an adequate job.

4 And this goes back to some of the
5 petitioners' concerns, too, because they've
6 all -- we've had many questions about whether
7 they felt their records were complete, were
8 they all there, were they -- you know, so this
9 is part of the reason we've been addressing
10 these at the previous SEC evaluations.

11 DR. MAURO: A question for you,
12 Mark. Right now in our data, it consistently
13 shows starting in about 1956 approximately 20
14 percent of the workers have more than four
15 bioassay samples per year. In other words, so
16 I don't know if that goes toward what you're
17 saying.

18 In other words, we know that, you
19 know, that means some have less.

20 MEMBER GRIFFON: Right.

21 DR. MAURO: Now I guess what would
22 be done? That is let's say we go -- I'm not

1 quite sure what you would do to check what
2 you're saying. The fact that we know, I mean
3 -- we could say that right now. That
4 consistently, you know, 20 to 30 percent of
5 the workers have more than four bioassay
6 samples per year.

7 MEMBER ZIEMER: But I don't think
8 that answers that per se because what would be
9 an adequate number of bioassay samples is very
10 dependent on where you are working and what
11 you're doing. Or in the case of the accident
12 where it looks like they were sampling every
13 day --

14 DR. MAURO: Right.

15 MEMBER GRIFFON: Well and I don't
16 that was an accident.

17 MEMBER ZIEMER: No, no, whatever
18 it was.

19 MEMBER GRIFFON: Yes.

20 MEMBER ZIEMER: I think you are
21 looking for patterns where people who should
22 have been sampled were not. And I --

1 MEMBER GRIFFON: Or the data is
2 not there, yes.

3 MEMBER ZIEMER: And I don't think
4 you necessarily find that from these averages.

5 MEMBER GRIFFON: No.

6 MEMBER ZIEMER: In Rocky Flats
7 case, you went through some -- you did some
8 selective sampling of files.

9 MEMBER GRIFFON: Arjun was
10 involved in this so he can describe -- for
11 data completeness for Rocky Flats.

12 MEMBER ZIEMER: Yes, you sampled a
13 number of cases and then looked at that. And
14 you're looking for either major gaps -- for
15 example, here I suppose you would select some
16 millmen or whatever it is and ask that
17 question.

18 But how did you answer it at Rocky
19 Flats?

20 MEMBER GRIFFON: And then the
21 other -- and we looked at externals, too. We
22 looked at whether they, you know --

1 MEMBER ZIEMER: Yes, are there big
2 gaps, right.

3 DR. MAKHIJANI: Well, at Rocky
4 Flats, at the direction of the working group,
5 we actually took a very small sample because
6 the working group did not want an extensive --

7 MEMBER ZIEMER: Right.
8 Understood.

9 DR. MAKHIJANI: And then what
10 happened is --

11 MEMBER ZIEMER: It was a sampling.

12 DR. MAKHIJANI: -- yes, well, we
13 looked at some cases but we did a very crude
14 look. We didn't have job categories, for
15 instance. So this turned out to be an issue
16 eventually in the discussion and there was
17 some criticism that we hadn't done enough
18 sampling but -- so there was a problem and
19 this tension that we -- how much do you do
20 initially in limiting the effort?

21 And then when you are ready to
22 vote or decide all the issues, put them to

1 bed, there was a controversy over whether we'd
2 done enough. And specifically, I think, it
3 was over the lack of enough examination of job
4 categories or buildings. I don't remember
5 what the issue was.

6 But definitely we did a rather
7 more crude look than what we've been
8 discussing this morning.

9 MEMBER GRIFFON: And we may need -
10 - I don't know what's -- when you submitted a
11 plan before, John, that wasn't answering this
12 question for data completeness?

13 DR. MAURO: No.

14 MEMBER GRIFFON: It was a
15 different data completeness sampling. So I
16 mean I would think we would have to have a
17 similar step here is that we need to get a
18 sense of how big a sample you think is going
19 to do it.

20 And, again, it may, you know,
21 unfortunately, you know, we do, we've been
22 running two years on this. You know we have

1 to answer some questions here. So, you know,
2 I don't know that we want to go back in, you
3 know, more than 1,000 claims.

4 I mean obviously I don't think you
5 want to do 300 of them, you know. So, you
6 know, what's the right population?

7 DR. MAKHIJANI: If I might say
8 something? We've been also doing a sampling
9 plan at Nevada Test Site. And just personally
10 from a technical point of view, and Harry has
11 been involved in that, I'm actually quite
12 happy with what we did there.

13 We had sampled 20 in each of six
14 job categories. And I think --

15 MEMBER GRIFFON: A similar
16 approach might work, right?

17 DR. MAKHIJANI: -- we got a pretty
18 good result. It was a fair effort. It was a
19 small fraction of the population of workers.
20 But I think in the end, we got something that
21 is very reliable in my opinion.

22 DR. MAURO: In that case, though,

1 we worked with logbooks, handwritten logbooks
2 and --

3 DR. MAKHIJANI: Handwritten
4 logbooks and records. It was not a non-
5 trivial effort.

6 DR. MAURO: It was a big effort,
7 yes.

8 DR. MAKHIJANI: But here, I think,
9 I'm a little bit confused because the
10 completeness plan that we presented to you
11 last October was along the lines of, you know,
12 taking something -- some lessons learned from
13 Rocky Flats and then doing a little bit more
14 elaborate thing and -- but looking at
15 completeness of data. Now what we're talking
16 about is something different.

17 MEMBER GRIFFON: Well, I thought
18 that was the same. I thought that's what we
19 wanted to go back to. Now I don't know why we
20 lost that. Maybe it was because the same was
21 so large that we were concerned about how long
22 it would take.

1 DR. MAURO: It wasn't -- it was
2 small.

3 DR. MAKHIJANI: It wasn't very
4 large. Well, there were three different
5 files.

6 MEMBER GRIFFON: I mean --

7 MR. ROLFES: While we're searching
8 for that, I can point out that the HIS-20
9 database table, this is from our HIS-20 draft
10 analysis, version 2 that I mentioned before.
11 It says the HIS-20_B_bioassaytable contains
12 435,982 records of which 431,016 are
13 urinalysis records to below 406,145 are
14 identified as U total with units of micrograms
15 per liter.

16 Also you were asking about the
17 references that we used, there are two tables
18 associated with that summary report, which we
19 have transcribed data from PDFs into these
20 Excel spreadsheets for each individual
21 reference ID, which we've mentioned in these
22 two Excel spreadsheets. We've got that data

1 that we used and some notes associated with
2 that.

3 MR. ROLFES: That's what I said,
4 even if they're not on the document review as
5 a reference, they're there. So we can --

6 MEMBER GRIFFON: Right. So they'd
7 be easily recovered from the site research
8 database.

9 MR. ROLFES: Also, it didn't
10 escape before -- I forgot that we also did, in
11 addition to, you know, evaluating the uranium
12 analysis results and comparing those within
13 HIS-20, we did also take some of the other
14 results that were -- essentially any bioassay
15 data that was collected and put into HIS-20.

16 And so there's plutonium,
17 urinalysis results which would also be helpful
18 for us in reconstructing someone's recycled
19 uranium intake or potential recycled uranium
20 intake.

21 So it's not just a small, simple,
22 only uranium inter-comparison that we did in

1 a data comparison but essentially all the data
2 that were collected and compiled in this
3 database we sampled and determined whether the
4 data was sufficient, whether the data was
5 accurate. And so there is quite a large
6 amount of data that was analyzed and presented
7 in these files.

8 MEMBER GRIFFON: But I mean going
9 back to the data completeness thing, I don't -
10 - if we dropped it, it wasn't -- I didn't --
11 I don't know if the work group meant to but I
12 didn't mean to.

13 DR. MAKHIJANI: Yes, the two
14 options that we -- Harry, are you still on the
15 line?

16 MR. CHMELYNSKI: Yes.

17 DR. MAKHIJANI: Do you have the
18 October 6 plan open -- correct me if I'm
19 saying anything wrong -- maybe you should take
20 this over -- in Table 3 of that plan, there
21 are two different sample sizes that were
22 presented: 150 and 300.

1 MR. CHMELYNSKI: Right.

2 DR. MAKHIJANI: And of course you
3 have different degrees of statistical
4 confidence.

5 MEMBER GRIFFON: And I think even
6 300, you're talking about a third of the
7 claims.

8 DR. MAKHIJANI: Yes. So there is
9 -- 150 is 13 percent or about. Then the table
10 had parsed out how many workers you would get
11 in each plant and how many workers you would
12 get in each of several job categories.

13 MEMBER GRIFFON: Right.

14 DR. MAKHIJANI: And I think, you
15 know, just looking from the Nevada experience
16 where we already completed this thing --

17 MEMBER GRIFFON: Yes.

18 DR. MAKHIJANI: -- we did 120
19 there. The number of job categories fewer in
20 terms of what we were really looking for
21 because we took predefined job categories.
22 There are really far more job categories at

1 Fernald.

2 But if you look at the important
3 job categories in terms of exposure potential,
4 you could limit them and do something like the
5 150 option.

6 Harry, am I off base?

7 MR. CHMELYNSKI: I think we're in
8 the same ballpark here. It was a different
9 study that we did then but yes, I think about
10 the same.

11 DR. MAURO: We did a lot of dose
12 reconstruction audits for Fernald. I don't
13 know how many we have. Maybe Kathy would look
14 -- I don't know, Kathy, are you still on the
15 line?

16 MEMBER ZIEMER: You would know
17 something about completeness from them.

18 DR. MAURO: Yes. I mean I don't
19 know how many we did but that's what we do in
20 a dose reconstruction.

21 MEMBER ZIEMER: Yes, right.

22 DR. MAURO: You know we may

1 already have at least something intelligent to
2 say about this based on the results of -- I
3 know we must have done I don't know five, six,
4 ten, maybe more.

5 DR. BEHLING: John?

6 DR. MAURO: Yes, Hans?

7 DR. BEHLING: This is Hans. Kathy
8 is not in the office but I can get here and
9 get back to you after lunch perhaps.

10 DR. MAURO: That would be great.
11 It turns out, you know, we have a significant
12 number of Fernald cases that we reviewed.
13 Obviously we'd be able to say something about
14 completeness of the data and the ability to
15 reconstruct those, external and internal, and
16 what the records look like for those workers.

17 DR. BEHLING: Specifically, what
18 is the question so I can direct her focus on
19 getting you the answer?

20 MEMBER GRIFFON: How many Fernald
21 cases?

22 DR. MAURO: How many Fernald cases

1 did we review?

2 DR. BEHLING: Okay.

3 DR. MAURO: Yes, to date I know we
4 reviewed about 240 cases. You know how many
5 of those were Fernald cases?

6 MEMBER GRIFFON: But I can't
7 imagine it is more than 20. And you're
8 talking 150 here, you know, so --

9 DR. MAURO: But it's nice to take
10 advantage of this.

11 MEMBER GRIFFON: Right, right, no,
12 I agree.

13 DR. MAURO: Thank you.

14 MEMBER GRIFFON: It still seems
15 high to me.

16 DR. NETON: It seems like you're
17 getting back into that original issue was do
18 we have data for the right classes of workers?
19 And it seems to me that is very well
20 established that we have 90 percent of the
21 workers with a monitoring badge.

22 I don't know looking at the

1 database itself if it's going to be any more
2 instructive. I mean --

3 MEMBER GRIFFON: No -- well, you
4 mean the individual claims files?

5 DR. NETON: I think the claims
6 files is where you really probably need to
7 look.

8 MEMBER GRIFFON: That's what we're
9 talking here.

10 DR. NETON: That's what I'm
11 talking about. Originally the sampling plan
12 was not claims files, was it? Or just to go
13 back and look at how many workers -- or how
14 many millrights were, you know, sampled.

15 DR. MAKHIJANI: The original plan
16 was to look -- go to the claims files to look
17 at --

18 MEMBER GRIFFON: That's what I
19 thought. Like we did with Rocky Flats, yes.

20 And then we saw -- I think --
21 personally I thought 150, I was trying to
22 think of a way that -- yes, can we reduce that

1 and still keep the statistical significance.

2 I mean we did have a problem,
3 you're right. And we got criticized in Rocky
4 for going too small. But we had to weigh this
5 thing of, you know, how long, how much money
6 are we going to spend on this task?

7 DR. MAKHIJANI: And if I recall,
8 we did 40 or 50 workers at Rocky Flats.

9 MEMBER GRIFFON: I think so, yes,
10 somewhere in that range, yes.

11 MEMBER ZIEMER: Well, if there was
12 a systematic problem, you would expect it to
13 be showing up in the claims that you monitored
14 to start with.

15 DR. MAURO: Yes, that should be
16 revealed.

17 MEMBER ZIEMER: So it would
18 certainly be a starting point.

19 DR. MAURO: By the way, the
20 original budget claim that was covered last
21 time was 200 workers. So it was not a large
22 effort to do the thing that we describe here.

1 It might have been 200 work hours.

2 DR. MAKHIJANI: And that might
3 have been a HIS-20 examination --

4 DR. MAURO: It was.

5 DR. MAKHIJANI: -- and not a paper
6 file --

7 DR. MAURO: Not a paper file.

8 MEMBER GRIFFON: That was my
9 recollection. I was thinking about it as a
10 paper record.

11 DR. MAKHIJANI: So maybe that's
12 where the problem arose.

13 MEMBER GRIFFON: Because HIS-20, I
14 think you're right, we already had that. So
15 I think we have to think of a way to reduce
16 that number of -- if we can -- I mean if, you
17 know --

18 DR. MAKHIJANI: I think you talked
19 about this with me, Paul, in terms of what it
20 took for NTS. Ultimately when the thing got
21 going, it was several hours, four, six hours.

22 DR. MAKHIJANI: So it's not

1 insignificant but it is not as huge as you
2 would think. I mean the SC&A young people
3 that did this doc are pretty good at it.

4 MEMBER GRIFFON: You're still 600
5 to 900 work hours.

6 DR. MAKHIJANI: Yes, it's not
7 trivial. Yes, it's not trivial.

8 MEMBER ZIEMER: Mark, you
9 described what, in a sense, was NIOSH's
10 evaluation of the completeness of data.

11 MR. ROLFES: Correct.

12 MEMBER ZIEMER: Is that -- what
13 you described, did you ever formalize that in
14 any kind of a summary report?

15 I mean is there an equivalent
16 report to your other -- what was the other one
17 -- the report on the validity -- the validity
18 report. Was there a completeness report
19 similar to that?

20 MEMBER GRIFFON: I don't think we
21 ever evaluated -- I don't think NIOSH ever
22 evaluated -- this, the way I'm talking about

1 completeness here.

2 MR. ROLFES: Correct. What we've
3 done or what we were tasked by the Advisory
4 Board to do or the working group to do was to
5 ensure that the data entered into HIS-20 was
6 accurately entered.

7 MEMBER ZIEMER: Yes, that's it.

8 MR. ROLFES: I don't believe we've
9 gone and sampled a population of workers to
10 independently also verify that, you know --

11 MEMBER ZIEMER: No, but in a
12 sense, in doing dose reconstructions -- and
13 you've done a lot of those at Fernald, you
14 have some sense of completeness of data.

15 MR. ROLFES: With every dose
16 reconstruction that is completed, we do, in
17 fact, determine whether the data are
18 sufficient on a case-by-case basis for a dose
19 reconstruction.

20 MEMBER ZIEMER: Right. And does
21 that -- so does this show up anywhere?

22 MEMBER GRIFFON: You don't look at

1 it systemically though. You look at it on a
2 case-by-case --

3 MR. ROLFES: Right. It's not done
4 across the Board.

5 MEMBER GRIFFON: Yes.

6 MEMBER ZIEMER: Well, what --
7 okay, I'm trying to think about -- if you
8 systematically were finding the data to be
9 incomplete, would that show up somewhere in
10 your system as a report where you would alert
11 dose reconstructors?

12 DR. NETON: It would be on our
13 Gantt chart tracking system saying we have a -
14 - we don't have a method to move forward with
15 these cases.

16 We track these all the time. Why
17 we aren't get them out the door, there's
18 always a technical reason identifying it.
19 Well, we don't have sufficient bioassay data
20 to move this forward.

21 MEMBER ZIEMER: Right.

22 MEMBER GRIFFON: Yes but that's a

1 little different question than I'm asking. I
2 mean --

3 MEMBER ZIEMER: Well, it's part of
4 the same question but it's sort of -- it's
5 less formalized.

6 MEMBER GRIFFON: Yes.

7 MEMBER ZIEMER: In other words --

8 DR. NETON: Yes, we don't --

9 MEMBER ZIEMER: -- if there was a
10 data incompleteness issue, it would show up in
11 terms of how you were handling cases. And
12 we're looking for some way to sort of certify
13 that, in fact, the data are complete.

14 I was trying to see if there was a
15 way we could say yes --

16 DR. NETON: I've always maintained
17 and I'll say it again, I think the proof is in
18 how we've done the dose reconstruction.

19 MEMBER ZIEMER: Right.

20 DR. NETON: We've done 900 and
21 something dose reconstructions.

22 MEMBER ZIEMER: Right.

1 MEMBER GRIFFON: Right.

2 MEMBER ZIEMER: And that's why in
3 the ones that you've sampled that -- and are
4 those enough cases for us to satisfactorily
5 answer the question? I guess we need to know
6 how many cases there are.

7 MEMBER GRIFFON: Yes. But I don't
8 even think -- you know when we do -- when we
9 do dose reconstruction reviews, we're also
10 looking at did they -- I mean basically it's
11 a detailed review of did they follow the
12 procedures?

13 So if the procedure says, you
14 know, you have this many -- I mean I don't
15 think anybody -- and I'm pretty sure we never
16 looked and said okay, this worker in Fernald
17 should have been on a quarterly but we only
18 have an annual -- you know, it looks like they
19 have annual data. I don't know if that would
20 have come up in SC&A's review of cases.

21 DR. NETON: Yes, I'm not sure if
22 quarterly or annual sampling makes any

1 difference in the way we do --

2 MEMBER GRIFFON: Yes, those are
3 modeling. I agree. But it raises -- if you
4 see a systemic problem across the Board, you
5 wonder what happened to the data? How did --
6 where did this go?

7 If this person was supposed to be
8 measured every -- you know what I mean? It
9 may not -- like Mark's example, if you have
10 one sample in 1989 but this was a chemical
11 operator from 1950, he's probably right.

12 You can still use a chronic model
13 and bound but what happened to all -- you know
14 why is it all missing, you know? And I don't
15 think that we're going to find it.

16 DR. NETON: I think you're asking
17 a question you can't really answer. I mean if
18 there's -- if you think you should have been
19 monitored quarterly and there's annual
20 samples, we don't know whether the plant just
21 didn't follow their own procedures or the data
22 are lost. Or does it really make a

1 difference?

2 DR. MAURO: Well, what we did have
3 in our audits --

4 MEMBER GRIFFON: Well, it gives
5 you a sense of the quality of the data that
6 you're dealing with though. You know like if
7 -- for the quality of the program.

8 I mean for me if they have
9 protocols to sample certain work categories by
10 month and certain ones by quarters and certain
11 ones annually and if everything was annual in
12 the thing, it raises some questions to me on
13 what happened between, you know, protocol and
14 the data we've got in HIS-20 or whatever or in
15 the hard copy records.

16 DR. NETON: I don't they've got to
17 that level of granularity. I think something
18 along the lines of what John was talking about
19 earlier where you can take these people with
20 the higher exposure values, this list they had
21 of 20-something job categories.

22 And say well, were those people

1 indeed sampled more frequently than the people
2 in the lower categories? I mean that would --
3 and you have data to support that, yes or no.

4 And sort of draw a very bright
5 line and say well, if you've got to have
6 quarterly data for chemical operators and what
7 not --

8 MEMBER GRIFFON: I am not saying -
9 - I'm using these things as descriptors.

10 DR. NETON: Yes, yes, I
11 understand.

12 MEMBER GRIFFON: I mean, you know,
13 in Rocky Flats, we found several examples
14 where it didn't match. But at the end of the
15 day, we said there was no systemic, you know,
16 sort of intentional thing going on.

17 It was just once in a while it
18 didn't match. But no big deal. That's sort
19 of the -- that's the outcome we're looking not
20 to say, you know, not to try to answer every
21 mismatch. You know we don't want to answer
22 every mismatch. We want to look for trends,

1 I guess, is what I'm saying.

2 DR. MAKHIJANI: Jim, of the -- or
3 Mark, of the 950 dose reconstructions that
4 have been completed, typically when I've
5 looked at dose reconstructions, there has been
6 deficiency one way or another. And so most of
7 them would actually not have used the detailed
8 data.

9 DR. NETON: More than likely.

10 DR. MAKHIJANI: I don't know how
11 many -- we couldn't have had an assessment of
12 -- in going through your dose reconstruction
13 of --

14 DR. MAURO: No, but you do know --
15 I think the deficiency process has been
16 steered away from.

17 MEMBER GRIFFON: I don't mind
18 looking at those.

19 DR. MAURO: But in every dose
20 reconstruction we do, the first thing we do is
21 -- were there bioassay data for this worker
22 and were there fil badge data for this worker?

1 And we would capture that in the
2 record file. So we would know for every case
3 we reviewed. Now whether or not --

4 MEMBER GRIFFON: Because I know
5 we've had findings recently where we said, you
6 know, the individual had bioassay data and
7 should not have used this model. And NIOSH is
8 saying, yes, we're changing it over. We
9 should have used this.

10 DR. MAURO: Right. But remember
11 the question that is being posed though is
12 that let's say we have 15 cases that we
13 reviewed. They may have applied OTIB-4 or
14 some other deficiency method to quickly clear
15 this case.

16 Nevertheless, when we review it,
17 his file, that worker's file, if he had
18 bioassay data and he had film badge data, it
19 would be in his file and we'd have a table of
20 every single measurement and what the
21 measurement was and when it was taken.

22 And we would be able to say okay,

1 out of the 20 or whatever cases that we
2 reviewed, here's the worker and here's his
3 record. He worked here these years and here's
4 the bioassay samples that were collected.

5 MEMBER ZIEMER: You would also
6 know his job category.

7 DR. MAURO: And we'd know -- well,
8 to the extent that it was in his record.

9 MEMBER ZIEMER: Because you always
10 show that in your reports.

11 DR. MAURO: Oh, we do when we have
12 that recorded, yes, we do.

13 DR. NETON: Maybe we are doing
14 several different things here. I mean
15 wouldn't what Mark talked about earlier that
16 we've already done speak to some of this?
17 Which is if you went to the hard copy records
18 and made sure the HIS-20 database has all the
19 hard copy records or a nice sampling. And
20 we'd have the original data in there.

21 DR. MAURO: Well, I think I'm
22 hearing something different.

1 DR. NETON: We have the samples
2 that they took on the workers.

3 DR. MAURO: Right.

4 DR. NETON: Now the second
5 question is were the workers adequately
6 monitored is a different issue. So I think
7 the proof is in looking at each individual
8 case. If we've demonstrated we have the
9 records of the sample they took, we have what
10 we have. We don't appear to be missing large
11 chunks at least compared to the hard copy
12 records.

13 Now you can go back another step
14 and say they never got the hard copy records.
15 But I don't know how far you want to regress
16 back. So we have the data of the individual.
17 Now it's a judgment call. Do we have
18 sufficient data now that they took on this
19 person to reconstruct this dose? So I think
20 that's been done.

21 MEMBER GRIFFON: I think -- I
22 don't like the -- I mean I think the sample is

1 too big but I think actually there is some
2 usefulness in looking and saying -- I mean
3 let's think -- let's drop the bioassay
4 argument and go to the external dose size
5 because now you can't hang you hat on a sample
6 in 1990 anymore, right?

7 DR. MAURO: Correct.

8 MEMBER GRIFFON: So you got TLDs,
9 the person is supposed to be on, you know,
10 monthly TLDs. You have no data for, you know,
11 eight years or something. Then what do you
12 do?

13 Now in the dose reconstruction, I
14 know just -- I'm not sure what they -- well,
15 I'm not sure for Fernald what they would have
16 done.

17 MR. ROLFES: I think we explained
18 this pretty detailed in our site profile
19 because it came up as -- when women were not
20 monitored routinely. And we presented three
21 different methods that we could use to assess
22 their unmonitored dose. And I think we've,

1 you know, completed that.

2 MEMBER GRIFFON: So that was
3 unmonitored by design, right?

4 DR. NETON: Right. And remember
5 the security badges --

6 MEMBER GRIFFON: Go ahead.

7 DR. NETON: -- the security badge
8 is part of dosimeter for many, many years at
9 Fernald from very early on.

10 MEMBER GRIFFON: So we can't
11 imagine them not --

12 DR. NETON: It would be hard. I
13 mean we've been down this path before and
14 where it split and things but you raise a good
15 point. I mean -- well, I'm not --

16 MEMBER GRIFFON: The only thing
17 that remains for me is that I don't want to
18 get into the -- I think 150 -- just sitting
19 here, it seems large. And I'm sure there's
20 good statistics to back up why you chose that
21 number but I'm trying to think of something
22 less, you know, burdensome.

1 DR. NETON: Thirty seems to be a
2 really good number. Once you get to 30, it's
3 part of diminishing return.

4 MEMBER GRIFFON: Yes. And maybe
5 we don't have to -- you know maybe the job and
6 -- I mean I'd have to look back at the plan
7 you submitted before but maybe we don't have
8 to -- maybe there is a way to cull down that
9 number and get what we need to answer, you
10 know, because, you know, I don't know.

11 I mean we've got a number of
12 factors here. And if all of them are looking
13 good, I don't think we need to look at 150
14 cases for this aspect of it is what I'm kind
15 of getting at, you know. So --

16 DR. MAKHIJANI: I would agree. I
17 think in view of the very large number of
18 bioassay samples that there are and the fact
19 that more than 90 percent of the workers have
20 some sample, I think going through the same
21 exercise that we went at Nevada test site
22 where only 35 -- in the Nevada test site, it

1 was a much, much bigger issue at least in my
2 opinion because there you only got 35 percent
3 of the workers were monitored internally, if
4 I'm remembering the number right. It's on
5 that order.

6 And so you have a qualitatively
7 different situation. So the chance of your
8 coming across a worker who was never measured
9 at NTS is pretty high compared to Fernald
10 where it is pretty low. So --

11 MEMBER GRIFFON: There were -- I'm
12 trying to remember back to the Rocky Flats
13 although sometimes I try to forget it. I have
14 reasons why that's the case. But you're not
15 a production facility at Nevada.

16 DR. MAURO: Well, I'm not saying
17 we're good or bad. I'm just saying in terms
18 of you're likely to find in a sample size --
19 anyway, it doesn't matter --

20 MEMBER GRIFFON: But I mean one
21 thing -- the one thing that sort of came out
22 and this is part of the reason for going

1 forward is it may -- and I would like to get
2 that number down but I believe, and maybe I'm
3 wrong, Jim, but some of that '69, '70 stuff at
4 Rocky Flats showed up when we did this, you
5 know, completeness reviews that we did.

6 You know we sort of found, oh,
7 yes, look at this in '69. And then there was
8 the question of the fire and what happens --

9 DR. NETON: Right. And that was
10 my original objection to doing sort of
11 analysis because then there was always -- they
12 were on strike in that year and they moved
13 production from Plant 2 to --

14 MEMBER GRIFFON: But at the end of
15 the day, we got there. And we said okay,
16 there's good reasons for this, you know, but
17 that what the people are asking, too. You
18 know petitioners are asking, you know.

19 And we -- yes, it is time
20 consuming but we don't want to leave that
21 hanging out there, the concern from the public
22 is these records are, you know, are not good.

1 We have concerns about them. And this is --
2 you know, we've got to do this with rigor to
3 make sure. And if we put it to bed, we put it
4 bed, that's great.

5 But I think we've have to go
6 there. I'm just uncomfortable with the 150.

7 MEMBER ZIEMER: Well, let's say
8 you did a sampling, say it's ten, or it's 30,
9 or 150 -- hopefully it's not --

10 MEMBER GRIFFON: Hopefully it's
11 more like 30 or 50 but yes.

12 MEMBER ZIEMER: -- but, okay, you
13 go in and you pull a case. What are you going
14 to look at? The years worked? The number of
15 bioassay samples? Number of film badge
16 samples? And the job category and the plant.

17 MEMBER GRIFFON: Right.

18 MEMBER ZIEMER: And you could
19 table these.

20 DR. MAURO: And that's done, to
21 some extent, right now. It's already done.

22 MEMBER ZIEMER: For one part.

1 DR. MAURO: No, for the dose --

2 MEMBER ZIEMER: For the ones
3 you've already done, yes. But it doesn't look
4 to me -- that's just bean counting it looks to
5 me like.

6 MEMBER GRIFFON: Yes.

7 MEMBER ZIEMER: So it doesn't look
8 to me like it is a big time commitment.
9 You're not having to calculate anything. Just
10 -- you're just looking for some patterns here.
11 There's nothing about the tabling.

12 DR. MAURO: What we're really
13 talking about is let's make believe for a
14 minute that what you were asking is we want to
15 do an audit of Fernald dose reconstructions,
16 you know, we'd like to go in -- what happens
17 when we do that? You folks provide us with
18 some electronic files, which is the record for
19 this worker, which includes everything DOE
20 provided you regarding this person.

21 In a very short period of time, we
22 quickly go into their bioassay and we make a

1 table. And we say here we are. We count
2 them. And we say here they are and we put the
3 numbers in.

4 And that's the story. That's done
5 on day one. Okay, this is what we have. Then
6 we start the processes. How do they use that
7 data? Did they follow their procedure?

8 But you're not asking that
9 question. You're just sitting there saying
10 let's -- what do we have on this person.

11 MEMBER GRIFFON: Right. What's
12 their -- and is it appropriate for their job
13 and their building and their whatever?

14 DR. MAURO: Yes, so I mean if you
15 folks -- the way you always provide us with a
16 CD, with, you know, the 23 cases that we are
17 going to have to audit, I mean if you would
18 provide us with a random sample of 30 Fernald
19 cases and just say here, as if you were going
20 to do a dose reconstruction audit, but we're
21 not. We're just simply going to do this. I
22 think this --

1 MEMBER GRIFFON: Well, I'd like to
2 make sure -- think about the 30 because that's
3 a big difference than your 150.

4 DR. MAURO: I'm saying we could do
5 one thing. I mean I don't think that -- as
6 long as we're not doing an analysis, did you
7 follow you procedures, and then to match your
8 numbers because, you know --

9 MEMBER GRIFFON: Think about the
10 data and not the dose, not the dose.

11 DR. MAURO: I don't think this is
12 a -- each case would go very quickly.

13 MEMBER GRIFFON: Yes, I think it's
14 pretty helpful.

15 DR. MAURO: A few hours a case.

16 MR. CHMELYNSKI: John, I'm going
17 to interject here. The previous studies --

18 MR. KATZ: Can you identify
19 yourself please?

20 MR. CHMELYNSKI: I'm sorry. This
21 is Harry Chmelynski.

22 MR. KATZ: Thanks, Harry.

1 MR. CHMELYNSKI: In the previous
2 study, we were looking at a completely
3 different question which was how many records
4 would we have to look at in order to determine
5 whether sampling -- to determine accurately
6 whether sampling was done quarterly or monthly
7 or annually over a broad number of cases.

8 Here we're looking at individual
9 cases. So I don't think the 150 has anything
10 to do with what we're doing here.

11 MEMBER GRIFFON: Okay. Good.
12 Good.

13 MR. KATZ: Thanks, Harry.

14 MR. CHMELYNSKI: Okay.

15 MS. BEHLING: Excuse me, John,
16 this is Kathy Behling.

17 DR. MAURO: Yes?

18 MS. BEHLING: I guess -- I don't
19 know whether it's still relevant to your
20 conversation but I guess you were interested
21 in knowing how many cases we reviewed from
22 Fernald as the first 258 cases. I quickly

1 looked that number up. We've looked at 15
2 Fernald cases.

3 MEMBER ZIEMER: There you go.

4 MS. BEHLING: Now of those 15, six
5 were maximizing cases. They were early on or
6 were minimized. And only five are best
7 estimates or what they term full internal and
8 external.

9 And I haven't had a chance to
10 really go into those records or look in-depth
11 at what we did there. But I can certainly do
12 that if it would help.

13 MEMBER GRIFFON: I don't think we
14 need it right away but yes, you might have
15 those cases to work on. You might have those
16 cases to work on, yes, yes.

17 DR. BEHLING: This is Hans
18 Behling, also from SC&A.

19 Regarding the issue of the
20 adequacy, I guess I do want to caution in
21 context with what Kathy was saying is that for
22 many of the bioassay data for Fernald, we have

1 data. But the question that we raised during
2 the review of the TBDs is how much of that
3 really requires default values. And, of
4 course, NIOSH has assured us most of the
5 default values are usually claimant-favorable
6 such as the uncertainty regarding -- since
7 most of the urine data was dosimetry data,
8 that doesn't really tell you exactly the
9 composition in terms of enrichment. It
10 doesn't tell you the chemical nature of the
11 uranium. And it doesn't tell you the
12 solubility for all these other things.

13 So we basically have a dose
14 reconstruction that has a core element to it
15 such as milligrams per liter of uranium in
16 urine. But then all the secondary factors are
17 basically default values.

18 So with regard to the accuracy,
19 well, it's a question of do we trust the
20 default values. And that's a topic of a
21 different discussion.

22 MEMBER GRIFFON: Right. Yes,

1 that's a different issue.

2 CHAIR CLAWSON: If I could
3 interject -- my belly is talking to me --
4 John, what I suggest is over lunch that you
5 kind of think about this because I don't want
6 to kind of have a knee-jerk reaction. I want
7 to make sure that we are getting exactly what
8 -- so we're all on the same board because
9 we've been kind of going around here.

10 Just kind of think about it a
11 little bit. And when we come back after
12 lunch, we'll discuss this a little bit more in
13 detail to make sure that everybody is on Board
14 with where we're at and what's asked of SC&A,
15 you know, if we could.

16 DR. MAURO: Kathy and Hans, I'm
17 going to give you a call during the break.
18 I'd like to talk to you a little bit about
19 what we can do with the data. If it is in
20 cases you have right now and it's something
21 that could be done expeditiously and maybe
22 inform this process.

1 MEMBER GRIFFON: And maybe talk
2 over break about the total number, too, that
3 you think would be sufficient.

4 DR. BEHLING: John, so give us a
5 call whenever.

6 DR. MAURO: Very good. Thank you.

7 CHAIR CLAWSON: We're done for
8 lunch.

9 MR. KATZ: Okay. We're breaking
10 for lunch. It's almost quarter to one. So
11 let's see, what time would you like to --
12 quarter to two, we will reconvene.

13 Thank you everybody on the phones.

14 (Whereupon, the above-entitled
15 matter went off the record at
16 12:43 p.m. and resumed at 1:50
17 p.m.)

18 MR. KATZ: Good afternoon. This
19 is Ted Katz with the Advisory Board of
20 Radiation Worker Health. It's the Fernald
21 Working Group, and we have just returned
22 having broken for lunch, and that's all I have

1 to say, but Brad you can --

2 CHAIRMAN CLAWSON: When we left
3 for lunch, we were debating and questioning
4 back and forth with SC&A on this sampling plan
5 that we were going to do, and I've asked John
6 to more clearly define what he'd like to do,
7 so I'll turn that over to John and we'll go
8 from there.

9 DR. MAURO: I called Dr. Behling
10 during lunch and talked about 14 -- these 14
11 cases that we did. That's a good place to
12 start. And I said you did a table on the 14
13 cases. This is -- we'll intend to look at
14 them, they might be useful. This is what I
15 explained to him over the phone, and see if
16 everyone agrees this is the kind of thing we'd
17 like to see.

18 MEMBER ZIEMER: Talk loud.

19 DR. MAURO: Yes. Basically, I
20 made a little blank table that we filled in.
21 There's the person, Person Number One, Person
22 Number Two, all the way through the 14th

1 person. The next column would be his job
2 title. What did he do, if you can get that.
3 And usually you can.

4 The next column would be the
5 number your worked, 52 to 72.

6 The next one is what's the total
7 number of bioassay samples that were collected
8 from that worker over that time period.

9 These are the changeouts that were
10 collected from that worker over that time
11 period.

12 Now that would be a very close
13 snapshot picture of completeness. You know,
14 if you see some zeroes or you -- you know what
15 to expect. You've got a person that has a
16 fairly comprehensive experimental program you
17 know it's going to be monthly.

18 Same thing as bioassay, quarterly,
19 you know. You want certain numbers to be in
20 there, and it's fairly complete. Is this what
21 you had or not? And this is my question.

22 MEMBER GRIFFON: No.

1 DR. MAURO: No.

2 MEMBER GRIFFON: I mean it is
3 good -- it's good slushing criteria, you know,
4 but it's not what the final product --

5 DR. MAURO: No, no, no. I'm
6 saying with regard to the 14 cases.

7 MEMBER GRIFFON: I mean, it would
8 let you -- I think you should use those as you
9 can going forward, but, I mean, the final part
10 I think should look like you did for Rocky,
11 for each case.

12 You know, in other words that
13 Person Number One --

14 DR. MAURO: Yes.

15 MEMBER GRIFFON: -- they might
16 have worked 20 years. They might have four
17 different job titles.

18 DR. MAURO: Okay.

19 MEMBER GRIFFON: So you have to
20 look annually.

21 DR. MAURO: Okay, so you want --

22 MEMBER GRIFFON: You want to have

1 details.

2 DR. MAURO: That's why I put this
3 in.

4 MEMBER GRIFFON: Yes, yes.

5 DR. MAURO: Right now --

6 MEMBER GRIFFON: Okay, overall,
7 yes.

8 DR. MAURO: So in theory what
9 you're really saying is we could blow this
10 out, so for that person we could have a whole
11 page per person.

12 MEMBER GRIFFON: Yes.

13 DR. MAURO: We get into each year
14 where we get into each year. In other words,
15 for that person what's the date of 1952, 53,
16 54.

17 MEMBER GRIFFON: Because
18 otherwise you're not going to see trends or
19 gaps. I mean, if you just see total number of
20 bioassays in 30 years --

21 DR. MAURO: Right.

22 MEMBER GRIFFON: -- you know it

1 looks like 30 samples or 60 samples or
2 whatever, but it looks robust, but it could be
3 that from '70 to '75 every person there is
4 missing data, you know.

5 DR. MAURO: Okay, so --

6 MR. MAKHIJANI: And Mark just to
7 clarify a little bit of informal conversation
8 we were having on this point about what you
9 want so it's clear --

10 MEMBER GRIFFON: Yes.

11 MR. MAKHIJANI: -- to everyone.
12 Is your want not going to be an annual thing,
13 but you want something about the job category
14 and the expected monitoring? Is that what you
15 want?

16 MEMBER GRIFFON: Yes.

17 MEMBER ZIEMER: I don't think we
18 have to have them put in expected frequency.
19 I mean, we can make that judgment, but if
20 you're going to have -- for example, if the
21 person is a nomad for the first 10 years and
22 there'll be some frequency. And you can do it

1 by year.

2 I agree, it should probably be by
3 year --

4 MEMBER GRIFFON: Yes.

5 MEMBER ZIEMER: -- so you can see
6 if something is missing. And if they change
7 jobs and suddenly they're the -- you know,
8 they're working in the front office --

9 MEMBER GRIFFON: And if done
10 annual, then yes.

11 MEMBER ZIEMER: Yes, but -- yes,
12 so I think there's just more detail you're
13 talking about. But I don't think that adds
14 much more work.

15 MEMBER GRIFFON: I don't think
16 so. It would be copying it and pasting it.

17 MEMBER ZIEMER: You want to just
18 break the years out a little more.

19 DR. MAURO: So -- a separate page
20 for each year.

21 MEMBER GRIFFON: And for those 14
22 cases that you've done already. I mean, if

1 you don't have it in the spreadsheet, NIOSH
2 does. I mean, I know because reviewing these
3 cases --

4 DR. MAURO: Well, right now Kathy
5 is putting that back table together. We will
6 --

7 MEMBER GRIFFON: Right.

8 DR. MAURO: We will make the
9 table you just described, which should look a
10 lot like -- except that would be by year. In
11 other words --

12 MEMBER GRIFFON: Or by reading.
13 Really, by reading because it could be a sub
14 year, but anyway -- yes.

15 DR. MAURO: Well, a person --

16 MS. BEHLING: Excuse me, John.
17 This is Kathy. I'm listening in here and over
18 the lunch hour I started putting this table
19 together, and I'm putting it together just as
20 Mark explained, because it didn't seem to make
21 sense to me just to give you a total. And
22 I've already for two of the individuals, and

1 it's 15 total, for two of the individuals I
2 have already broke it down, broken it down by
3 year and if it's a partial year I say the year
4 behind it. I put in whether it's weekly or
5 bi-weekly for the film badges, and then I've
6 also broken down for the urinalysis by year.
7 So I'm already doing that.

8 DR. MAURO: Great.

9 MEMBER GRIFFON: So then I guess
10 the bigger question is how many overall cases
11 -- right, and you were saying probably 30 or
12 40 --

13 MEMBER ZIEMER: I think we can
14 make a judgment. If we come back and say we
15 can't reach any conclusions through this, we
16 can always instruct --

17 MEMBER GRIFFON: I think 30 and
18 if they're fairly random -- I mean, do you
19 think we should bias them in any way?

20 MEMBER ZIEMER: These working
21 cases typically are random.

22 MEMBER GRIFFON: Based on what we

1 have here.

2 MEMBER ZIEMER: And I would say
3 the others ought to be randomized in some
4 fashion.

5 MEMBER GRIFFON: The only thing I
6 was thinking was we might want to make sure
7 they're in the SEC period, you know. We have
8 a lot of years in '89 through 2006. That
9 might not be so useful.

10 And then also maybe if we want to
11 bias it at all, make sure we cover those early
12 years more than the later years. I don't know
13 if that -- that's sort of a judgment call, but
14 it seems to me there's no question about the
15 monitoring '52 through '54.

16 MEMBER PRESLEY: Stay away from
17 '52 to '54. I mean, that was a production
18 year up there. It's when they were building
19 buildings and facilities and stuff like that.

20 MEMBER GRIFFON: Well, it's a
21 construction year, yes.

22 MEMBER PRESLEY: And a lot of the

1 stuff was not on site until after 1954.

2 MEMBER GRIFFON: So that may be
3 difficult to evaluate whether they should have
4 been monitored during that time period is what
5 Bob's saying, I guess.

6 MR. MAKHIJANI: Well, we have to
7 look at the site profile and the site history,
8 and I think '52 was certainly a construction
9 year.

10 MEMBER GRIFFON: Yes.

11 MR. MAKHIJANI: I'm not so sure
12 about '54.

13 MR. MORRIS: There was still
14 construction going on in '54.

15 MEMBER GRIFFON: Yes, it was
16 still going on.

17 MEMBER PRESLEY: One of the
18 things by breaking that out by year like that,
19 it's going to be interesting to see is -- say
20 you had somebody that was a 10-year worker and
21 then in 10 years maybe he was promoted to a
22 foreman, when he's a foreman in the same area.

1 So what his dose reconstruction as
2 a worker and his dose reconstruction -- or
3 not dose reconstruction -- but his dose would
4 be as a foreman in the area. See if things
5 drop there.

6 That was one of the things I was
7 looking at on that table in there. You all
8 had things about workers and you also had
9 things about foremen, and the foremen doses
10 were super, super low. A lot of the times the
11 foremen are right out on the floor with the
12 workers, so that's something that we -- it's
13 going to be interesting to look at.

14 And your foremen didn't sit in an
15 office for eight hours a day. Generally, he
16 was right out in the middle of the operation
17 going on.

18 MEMBER GRIFFON: Right. So
19 that's -- I think that's the construct. Is
20 that clear?

21 CHAIRMAN CLAWSON: I heard Kathy
22 say 15.

1 MEMBER GRIFFON: Maybe you ought
2 to do 15 more?

3 DR. MAURO: Now the question
4 becomes with 15 more is what's the most
5 efficient way to do that to get the next set
6 of 15. Right now, you know, NIOSH provides us
7 with the CDs for those 15. Would it be the
8 most efficient way for NIOSH to provide us
9 with another set of 15 according to certain
10 criteria, or should we somehow just search the
11 database.

12 I'm not sure how best to do this.

13 MEMBER GRIFFON: They've got to
14 be finally adjudicated claims, right? We
15 usually don't review other --

16 MEMBER PRESLEY: I say take zero
17 -- you know, 10, 20, 30, 40, 50 until you get
18 that, and if they're not in the time frame,
19 then skip it and go on to the next zero, the
20 next 10.

21 MEMBER ZIEMER: You mean in the
22 order that they came in?

1 MEMBER PRESLEY: Yes.

2 MEMBER GRIFFON: I mean, I think
3 -- I don't know. My feeling is that's the
4 SC&A can sample.

5 MR. MAKHIJANI: Or Harry's done
6 this a number of times, and the only thing I
7 would suggest is that we do, as you were
8 saying, have a somewhat of a bias for people
9 who started in the '52 to '56 period, no
10 matter how long they went.

11 And that we also have something of
12 a check to see that we had a half a dozen or
13 10 workers who went through the eighties, up
14 to '89 --

15 MEMBER GRIFFON: Right.

16 MR. MAKHIJANI: -- so we're not
17 missing the tail end of the period, and we
18 make sure that we have that, but then that we
19 leave the rest to Harry. Let him --

20 MEMBER GRIFFON: Yes, we know
21 you're going to keep it at 30 cases overall,
22 so I don't think it's an issue. As long as

1 you describe exactly how you sample them, I
2 think that's fine.

3 (Simultaneous speakers.)

4 MS. BEHLING: Yes, we can do it
5 right off an octave.

6 MEMBER GRIFFON: Yes. I think
7 that will work if that's okay with everyone.

8 MR. MAKHIJANI: Harry must be
9 still on the line. Harry, are you on the
10 line?

11 MR. CHMELYNSKI: Yes, I'm still
12 here.

13 MR. MAKHIJANI: Does that sound
14 reasonable?

15 MR. CHMELYNSKI: Yes, that won't
16 be any problem to pick a small random sample.
17 We may do some sort of rejection sampling
18 though in order to make sure it meets the --

19 MEMBER ZIEMER: Yes, I would
20 rather him do it that way. Randomize it,
21 maybe you'll pick up 20 random numbers or
22 something.

1 MEMBER GRIFFON: Right.

2 MEMBER ZIEMER: Your first 15
3 randoms, though, if you're missing a couple of
4 criteria --

5 MEMBER GRIFFON: Exactly. All
6 right, that's it on that topic, I think.

7 CHAIRMAN CLAWSON: No more
8 discussion on --

9 MR. MAKHIJANI: Do we draw the
10 data from the HIS-20 database, or do we have
11 to go to the paper file?

12 MEMBER GRIFFON: I would suggest
13 going to the paper file. Isn't that the
14 bottom line for the dose reconstructors to use
15 the hard copy record, right? I would go with
16 the hard copy record.

17 CHAIRMAN CLAWSON: Ted, I guess
18 out of clarification do I need to go through
19 these as passed this, as done with this? That
20 sounds good. So, John, I guess the next step
21 we're going to go onto is RU.

22 DR. MAURO: Everyone should have

1 received the -- a report dated March 2009
2 titled SC&A's review of issues related to the
3 reconstruction of doses for workers exposed to
4 recycled uranium at Fernald, commentary on
5 NIOSH white paper.

6 During the last work group meeting
7 we were asked to review this issue, and mainly
8 the concern was the mix of radionuclides.

9 Right now the co-worker model approach being
10 used for dose reconstruction includes the
11 assumption that for every milligram of uranium
12 that's in urine, along with that uranium comes
13 plutonium-239, neptunium-237, technetium-99,
14 a list of radio nuclides which are trace
15 contributors due to recycling.

16 Now the -- when recycling actually
17 started -- the assumption that's going to be
18 made it begins at time zero, for all intents
19 and purposes. That is, every single bioassay
20 written -- Jim, again, correct me if I am
21 misrepresenting anything.

22 My understanding is just like the

1 two percent enrichment assumption which is
2 conservative as applied to the site, you're
3 going to assume that all uranium process is
4 recycled uranium with the mix identified on
5 page 11 of the report that I circulated to
6 everyone. So my starting point is page 11.

7 MEMBER PRESLEY: What date did
8 that come out, John?

9 DR. MAURO: Pardon me?

10 MEMBER PRESLEY: What date?

11 DR. MAURO: This report is dated
12 March 2009.

13 MEMBER ZIEMER: John, why don't
14 we have a specific day on these last couple of
15 reports?

16 DR. MAURO: That's on the bottom
17 in the footer. It says March 23rd, and the
18 cover says March.

19 MEMBER ZIEMER: Okay, I've got
20 you.

21 DR. MAURO: I believe page 11 --

22 MR. STIVER: John, could you

1 possibly resend them. Do you have it in email
2 form that you can send it to me?

3 MR. MAKHIJANI: I can send it.

4 MEMBER ZIEMER: And before you go
5 to page 11 --

6 MEMBER PRESLEY: Arjun, put me on
7 the distribution list, please.

8 MEMBER ZIEMER: I just have a
9 question, on page 10 you talk about Table 4-3.

10 DR. MAURO: Yes.

11 MEMBER ZIEMER: Now I had trouble
12 finding --

13 DR. MAURO: Okay, I can see where
14 you are referring to.

15 MEMBER ZIEMER: It's the last
16 paragraph 10. It says in Table 4-3 reproduced
17 above.

18 DR. MAURO: There's obviously some
19 mislabeling here.

20 MEMBER ZIEMER: Is that 3-3? But
21 if it's 3-3 -- well, in the other table I
22 couldn't read what -- on my copy I couldn't

1 read the items, so I --

2 DR. MAURO: How is the scanned
3 information?

4 MEMBER ZIEMER: On 3-7 --

5 DR. MAURO: Yes.

6 MEMBER ZIEMER: -- it didn't show
7 up, so I'm not sure what those columns were,
8 so I couldn't --

9 DR. MAURO: Yes, you're right.
10 I'm aware of that. I'm going to have to
11 clarify that for you.

12 MEMBER ZIEMER: Okay.

13 MR. MAKHIJANI: I am just trying
14 to send off the email.

15 MR. MORRIS: What you can read on
16 your screen is not readable on the printer.

17 MEMBER ZIEMER: Well, that part,
18 but when it refers to Table 4-3 it says that
19 it contains data for zirconium niobium-95 for
20 the first five months of '67.

21 Now if you look at Table 3-3, I
22 thought at first that was the -- just

1 mislabeled. I don't see anything about
2 zirconium niobium there.

3 MR. MAKHIJANI: It's called Table
4 10 in the text above. It's a pasted in table
5 from that source, NIOSH 2008. And zirconium
6 niobium, it's on page 11, and the zirconium
7 niobium line is the second last line.

8 MEMBER ZIEMER: Okay, I was going
9 back and looking above.

10 MR. MAKHIJANI: Yes -- no, just
11 below that sentence. In my computer at least
12 it's on the next page.

13 MEMBER ZIEMER: I got you.

14 MR. MAKHIJANI: For set total
15 uranium --

16 MEMBER ZIEMER: All right, yes,
17 yes, okay.

18 MR. RICH: John, this is Bryce
19 Rich.

20 DR. MAURO: Yes.

21 MR. RICH: Quick question.
22 You're going to be presenting the SC&A's

1 review of the white paper?

2 DR. MAURO: Yes.

3 MR. RICH: We've developed a
4 response to your findings which is still in
5 review. Do you want comments during the time
6 that you're presenting these points or --

7 DR. MAURO: Sure.

8 MR. RICH: -- or do you want to
9 wait until --

10 DR. MAURO: No. I mean, let's
11 talk about it.

12 MR. RICH: I just wanted the
13 board to know that they will be getting a
14 formal response, and a lot of these points
15 that are being made I think which you plan to
16 discuss today, I think there's a logical
17 response that should be discussed and would
18 probably be better once the formal report is
19 issued to the board.

20 I just wanted the board to know
21 that there's a formal response -- is hanging
22 in the balance here.

1 DR. MAURO: Well, from my
2 perspective if you have information to address
3 each of the 11 issues, that would be great.
4 Let's talk about it and, of course, that would
5 be followed up by your written response.
6 That's fine, let's talk about it.

7 MR. ROLFES: Yes, Bryce, this is
8 Mark. Please jump in with any response. I
9 know that you and Paul have been working on
10 this quite a bit, and I haven't had the
11 opportunity to speak with you in detail about
12 it. You are, in fact, working on it, so
13 please jump in with any new information that
14 you might have to discuss.

15 MR. RICH: Will do.

16 DR. MAURO: I guess -- basically,
17 we have 11 findings, but they can be grouped.
18 The first couple deal with inconsistencies --
19 let me step back.

20 Our understanding is the table
21 that we're looking at that was used to build
22 in effect your co-worker model, your default

1 set of mix of RU material was based on a
2 couple of DOE reports that -- and we reviewed
3 those reports. And we are finding that the
4 data -- the reports, and not the data -- we
5 don't have access to the data -- but our
6 review shows that there's inconsistencies in
7 quantities of material, amount of recycled
8 material, where it came from.

9 So it looks like there are
10 substantial differences in the historical
11 record of the amount of materials shipped from
12 various places, primarily Hanford, to Fernald.

13 Now that in and of itself is just
14 indicative that since everything is based on
15 the DOE records and that's the way Richard
16 came out with your RU numbers -- the fact that
17 there are very large discrepancies in that
18 information led us to the point that --

19 MR. RICH: John, let me comment
20 there.

21 DR. MAURO: Yes.

22 MR. RICH: It is indeed -- well,

1 let me -- let me step back a couple of points.
2 The decision that DOE, or AEC made at the time
3 to recycle uranium, that was a conscious
4 decision and criteria were set up -- the
5 specifications for the contaminants was
6 determined carefully and iterated. These
7 specifications between primarily Hanford
8 because they were the first in the Oak Ridge
9 complex.

10 There was no criteria given for
11 making the determination of what constituted
12 recycled uranium, and so a number of plants,
13 and Fernald being one of them, made the
14 judgment that once recycled uranium hit the
15 plant then everything was counted as recycled
16 uranium, even though they were in the very
17 early days processing metric tons of ores and
18 producing natural uranium that had no recycled
19 materials at all.

20 And the -- consequently, the major
21 effort that DOE went through in the most --
22 extending from 1985 to 2000 when the public

1 reports were published, they recognized almost
2 immediately that there were some discrepancies
3 in the mass quantities of material that was
4 moved back and forth from the sites.

5 They initiated a three-year study
6 and published another report in 2003, which
7 clarified an issue -- and by the way that
8 report in your report is the -- I think it's -
9 - let me see -- well, it's the colored table
10 on page seven, which is the Fernald receipts
11 data, and that comes from the 2003 DOE report
12 which clarified only the primary shipments
13 from the primary shipping sites, which was
14 Hanford, primarily -- Savannah River, and a
15 little bit from West Valley, and a little bit
16 less from the high enriched uranium processing
17 plant at the Idaho Chemical Processing Plant.

18 The -- those shipping
19 uncertainties were cleared up in that report.
20 The max LOEL between sites has not been
21 clarified, and so there are discrepancies.
22 Those discrepancies have been explained and I

1 think clarified in the white paper, the
2 differences in what they mean and constitute.

3 Just to make one additional
4 comment, the dose reconstruction approach is
5 based on determining a ratio of uranium to the
6 contaminants, and it's not really based on max
7 LOEL but on a confidence level that we know
8 the ratios. Those ratios were very well
9 documented at the shipping sites because they
10 were required to by regulations.

11 And so I'll just make those
12 statements at the beginning, John, so that
13 perhaps we don't need to spend too much time
14 on the fact that more uranium was shipped back
15 and forth that may or may not have been
16 recycled uranium.

17 MR. MAKHIJANI: Can I make a
18 couple of comments?

19 DR. MAURO: Sure.

20 MR. MAKHIJANI: Yes, I think --
21 you know, some of this stuff was cleared up in
22 the white paper from our previous comments

1 that were made in the review of the site
2 profile, but some were not cleared up. And
3 the different kinds of discrepancies that are
4 there in the first couple of findings, one is
5 the starting date.

6 Now as I read the white paper,
7 you're performing the start -- assigning these
8 doses in 1961, and our report shows that
9 recycled uranium exchange between Hanford or
10 other sites and Fernald started in '53 or '54.
11 So that's one discrepancy. The statement in
12 the white paper is that there were very small
13 shipments prior to '61, so presumably
14 inconsequential for dose.

15 MR. RICH: Arjun --

16 MR. MAKHIJANI: Yes.

17 MR. RICH: Is that Arjun?

18 MR. MAKHIJANI: Yes.

19 MR. RICH: Okay, let me respond
20 to that. You're right as a matter of fact
21 that, again, the daily 2003 report clarified
22 that, and the table that has been reproduced

1 from that 2003 report is on page seven, and
2 that indicates that they started shipping
3 small quantities of five metric tons in '58
4 and --

5 MR. MAKHIJANI: Yes, but that is
6 contradicted by the tables from DOE 2000 that
7 are reproduced farther down.

8 MR. RICH: As I said, Arjun, the
9 2003 reports and particularly the shipping
10 reports from Hanford were corrected by 2003.

11 MR. MAKHIJANI: No, no. No, no.
12 It's -- hold on. The 2003 report shows
13 absolutely no transactions before 1957. If
14 you go down and look at page eight of our
15 report and page nine you will see there two
16 reports that says -- these are DOE just pasted
17 in the table -- Hanford summary shipments to
18 Fernald.

19 And you look at that it will say -
20 - it shows July 1, 1954, to 30 of June 1955,
21 you can't see -- read the top lines, but
22 they're really natural uranium, enriched

1 uranium, and depleted uranium I think is what
2 those three columns are up there.

3 You'll see 266.2 metric tons were
4 shipped from Fernald to -- from Hanford to
5 Fernald in fiscal year 1955, and if you look
6 at the next table you'll see Hanford received
7 from recycled uranium from Fernald. You'll
8 actually see an item in fiscal year '54 of
9 2,735 metric tons of natural uranium of
10 Fernald's shipments to Hanford.

11 So this -- these transactions must
12 have started almost as soon as Hanford started
13 recovering uranium from the high-level waste
14 tanks.

15 MR. RICH: Arjun, shipments back
16 and forth between Hanford and Fernald did
17 occur prior to 1961. That's not in question.

18 The issue is was recycled uranium
19 sent back to Hanford, and did Hanford send
20 recycled uranium to Fernald?

21 MR. MAKHIJANI: That's what it
22 says here.

1 MR. RICH: The table says
2 recycled uranium, but that's the recycled
3 uranium report. That does not mean that those
4 shipments were recycled uranium, per se. And
5 that's what I'm saying is that the DOE 2003
6 report corrected the definition of recycled
7 uranium for -- primarily for the shipments
8 from Hanford to Fernald.

9 Now I remind you that the UO3 is
10 heavy stuff. A 55-gallon drum weighs about
11 900 pounds or so, and so the -- they did
12 receive, but it is a consistent report in the
13 entire Ohio report and the 2003 mass balance
14 report that they did not put into process
15 recycled uranium until 1961. That was
16 validated, verified by talking with
17 knowledgeable professionals whom we
18 interviewed specifically to that point.

19 MR. MAKHIJANI: Well, I obviously
20 wasn't there at the time. All I'm pointing
21 out is when you look at the DOE 2000, the
22 title of the report above the table number

1 says recycled uranium. It doesn't say uranium
2 shipments. It says recycled uranium, Hanford
3 shipments received from Fernald.

4 MR. RICH: Arjun, that's the
5 title of the section.

6 MR. MAKHIJANI: No, no, no. It
7 is not. Let me assure you it is not. I have
8 the DOE report and can certainly send it to
9 everybody.

10 MR. RICH: I have it right in
11 front of me -- section three, recycled
12 uranium, and then it starts out to talk about
13 what they're defining as the shipments in the
14 recycled uranium period.

15 And what I'm saying again is that
16 the daily 2003 report is the one that we have
17 accepted, and that is the one that corrected
18 the definition of what constituted recycled
19 uranium, based on the year '03 time and
20 Hanford, and then went straight to Fernald.

21 DR. MAURO: Based on this
22 conversation, I may have given some

1 misinformation. I was under the impression
2 that the recycled uranium mix, notwithstanding
3 the debate of when that started. I guess I
4 was under the impression that you were
5 universally going to assume it's all recycled
6 uranium, but I guess I'm wrong.

7 Right now your co-worker model or
8 your model -- it's not really a co-worker
9 model is not to assign those recycled uranium
10 until 1961. Just by way of clarification,
11 because I may have -- I may be wrong.

12 MR. RICH: The recommendation,
13 John, is that since there's sufficient
14 evidence to indicate that they didn't process
15 recycled uranium at Fernald. And by the way
16 there's in our formal response we have
17 extracted several -- specific information from
18 the Ohio report that indicates that -- and
19 that's a consistency that they did not process
20 recycled uranium until 1961.

21 Now it would be a simple thing to
22 extend that to the --

1 DR. NETON: Bryce, this is Jim
2 Neton. I've got a couple of questions. Maybe
3 I can shed some light on this.

4 You said that there was no
5 consistent definition of recycled uranium.
6 Could you expand a little bit on that because
7 we ran into this problem at other facilities
8 where they were calling recycled uranium
9 essentially any uranium scrap to have been
10 gathered from machining and such and then gone
11 back, remelted and reused. That was also
12 considered early on in the forties recycled
13 uranium, not to be confused with recycled
14 uranium that had originated and been
15 irradiated in a reactor.

16 MR. RICH: That's correct, Jim.
17 That's one of the problems.

18 DR. NETON: And that's one of the
19 problems.

20 MR. RICH: But even beyond that
21 the issue of -- once the recycled uranium from
22 the generating site hit the plant, some of the

1 plants simply defined every single -- all the
2 inventory in the plant as recycled uranium.

3 And in the case of Fernald they
4 were generating natural uranium specifically
5 from '53 to '62 period of time in thousands of
6 metric ton quantities. And they defined all
7 of that as recycled uranium, but it didn't,
8 you know -- and producing uranium metal parts
9 for Hanford from that site.

10 DR. NETON: It seems that we have
11 got definitional issue here.

12 MR. RICH: What we've done there
13 is, without trying to resolve this, just
14 simply accepting the fact that there is
15 discrepancy in the definition of recycled
16 uranium.

17 We have a surety from the three-
18 year review by DOE that the -- and they
19 intended to extend that to the secondary
20 shipment but didn't get that done.

21 But we have a fair degree of
22 confidence because of the extensive review

1 later that they knew exactly what came out of
2 the UO3 plant at Hanford and went to the other
3 sites, and that then qualifies as recycled
4 uranium, and that's the only uranium that
5 inserted the contaminants that we're talking
6 about into the system.

7 DR. MAURO: Then am I correct
8 that you're not going to assume recycled
9 uranium beginning from the very beginning of
10 operations, even though it assumed recycled
11 uranium?

12 MR. RICH: It is the
13 recommendation of the white paper that it need
14 not be considered prior to 1961.

15 DR. NETON: That is not
16 represented.

17 DR. MAURO: Okay, that corrected
18 my previous statement. Thank you.

19 MEMBER ZIEMER: Bryce, Paul
20 Ziemer here.

21 MR. RICH: Yes.

22 MEMBER ZIEMER: Could you --

1 we're trying to pull up this report here, Mark
2 and I -- or Mark is mainly, but what -- what's
3 in the report that we're looking at from SC&A
4 it's called Table 3-7. I guess you have that
5 report; it's on page eight of the report,
6 where it says recycled uranium did I
7 understand you to say that that was the title
8 of the chapter from which this table was
9 extracted?

10 MR. RICH: Yes.

11 MEMBER ZIEMER: So there's a
12 chapter called recycled uranium?

13 MR. RICH: Yes, that's section
14 three.

15 MEMBER ZIEMER: And then there's
16 some other tables and then -- and some
17 narration, and then this table appears --

18 MR. RICH: Yes.

19 MEMBER ZIEMER: -- which is a
20 summary of shipments, and the table title has
21 nothing about recycled in the title of the --

22 MR. RICH: Well, initially --

1 when Hanford put out their mass balance report
2 as part of the overall DOE effort they -- it
3 was a recycled uranium report.

4 MEMBER ZIEMER: Well, I
5 understand that. Yes, I was just trying to
6 clarify, because I think we originally thought
7 that the table had as part of its heading
8 recycled uranium.

9 MR. RICH: And they could have
10 intended that because of the fact that they
11 recycled. You know --

12 MEMBER ZIEMER: I see what you're
13 saying.

14 MR. RICH: They got, as Jim
15 pointed out, they got --

16 MEMBER ZIEMER: The broad --

17 MR. RICH: -- natural uranium
18 metal parts from Fernald --

19 MEMBER ZIEMER: Yes.

20 MR. RICH: -- and then they
21 processed it and had a bunch of scrap after
22 they'd made the fuel elements themselves, and

1 they sent that back.

2 MEMBER ZIEMER: Got you.

3 MR. RICH: So they recycled that.

4 It was not recycled uranium in the sense that
5 we --

6 MEMBER ZIEMER: Got you.

7 MR. RICH: It came out of the UO3
8 recycled uranium plant at Hanford. And so the
9 consequence, there is legitimate confusion
10 about what -- how much recycled uranium, but
11 the 2003 cleared that up, at least how much
12 was injected into the system. And that's
13 based on recorded analysis, primarily
14 plutonium but neptunium and technetium and
15 they did make gross -- right from the very
16 start when they started shipping from the UO3
17 plant, they made gross beta and gross gamma
18 analyses and shipped it gradually to -- well,
19 that's a topic specific on gross -- on a fixed
20 amount of uranium samples compared to aged
21 uranium.

22 MEMBER ZIEMER: Yes, thanks,

1 Bryce.

2 DR. MAURO: Well, good. It
3 sounds like that there's a response to our
4 concern about this confusing information.

5 MR. MAKHIJANI: We'll just have
6 to look at it.

7 DR. MAURO: We'll have to look at
8 it.

9 MR. MAKHIJANI: And I need to
10 find the reference from which that thing was
11 taken.

12 MR. RICH: Those come from
13 section three.

14 DR. MAURO: And we -- by the way,
15 we also agree that the real issue is the mix,
16 notwithstanding --

17 MR. MAKHIJANI: I'm not finding
18 it in the Ohio field office report. It might
19 be a numbering mistake.

20 MEMBER ZIEMER: Is the DOE report
21 -- is that the one out of the Ohio field
22 office, Bryce?

1 MR. RICH: Yes.

2 MEMBER ZIEMER: DOE --

3 MR. RICH: No, no, it's the one
4 on the Hanford field office.

5 MEMBER ZIEMER: Okay, so it's SRDB
6 ref IB --

7 MR. RICH: BR 2003 according to -
8 -

9 MEMBER ZIEMER: The June 30,
10 2000, report?

11 MR. RICH: Yes, June -- well it's
12 a July 5th is the date on the CRL report.

13 MEMBER ZIEMER: I'm actually
14 looking at SC&A's references, so maybe they
15 didn't cite this one.

16 MR. MAKHIJANI: I know that we
17 used the same reference as the white paper, to
18 be not confusing.

19 MR. RICH: I see. You're talking
20 about the --

21 MEMBER ZIEMER: I was again
22 trying to find the report that the table is

1 came from. I think it's the DOE report.

2 MR. RICH: It is the DOE --

3 MEMBER ZIEMER: Is it the 2003
4 report?

5 MR. RICH: Two thousand A report.

6 MEMBER ZIEMER: Here it is.

7 Okay, got it. Thanks.

8 MR. RICH: It's the --

9 MEMBER ZIEMER: Review of
10 Generation and Flow of Recycled Uranium at
11 Hanford?

12 MR. RICH: Right.

13 MEMBER ZIEMER: Yes, good.
14 Thanks.

15 MR. RICH: By the way, these are
16 very lengthy documents, thousands of pages a
17 piece, so --

18 MEMBER ZIEMER: Yes, we won't
19 read them into the record.

20 MR. RICH: Thank you.

21 DR. MAURO: The real issue, the
22 more direct issue is the mix, and I think --

1 again, looking at Table 10, page 11 of our
2 report, the question becomes -- in that column
3 where it says mass concentration of parts per
4 billion uranium, we looked into that to see,
5 okay, is the literature on which that -- those
6 numbers are based, does it make a compelling
7 case.

8 And what we found is as follows:
9 Clearly, the 100 part per billion number --
10 when you look over the entire duration of when
11 recycled uranium was being handled, that
12 number overall is a sound number to represent
13 -- for example, if a person were working there
14 for an entire time period, assuming that all
15 other -- let's say '61 on -- assuming one
16 hundred parts per billion would probably be
17 claimant favorable because you've demonstrated
18 what the data in general shown that the parts
19 per billion of plutonium is generally less
20 than that, except there are some exceptions.

21 And this is where we felt we a
22 hard time convincing ourselves there may have

1 been time periods and locations where people
2 might have been exposed to higher values, and
3 we could not discern.

4 There were two reasons we say
5 that, two reasons. The first is in going into
6 the reports that stand behind us, we were not
7 able to get outstanding data that -- one of
8 the inquiries we made is that --

9 MR. RICH: John, I can't hear you
10 very well.

11 DR. MAURO: When we were doing
12 our work on this one of the things we were
13 hoping to look at was the original data, the
14 data set that was used by DOE to come up with
15 their reports. We really had to go to the
16 original data, that really only had are the
17 reports, the DOE reports themselves which even
18 though they are large reports, they don't
19 actually give you the original data upon which
20 these numbers are based.

21 So that was one -- something to
22 look for to convince ourselves that that 100

1 number was a well-founded number.

2 DR. NETON: Are you saying that
3 there were periods of time where there were
4 greater than 100 parts per billion plutonium
5 at Fernald?

6 DR. MAURO: And there were people
7 working on it for protracted periods of time.

8 MR. RICH: John, I'll make
9 another comment at this point. The Ohio
10 report, of course, dealt with the historical
11 levels of these contaminants primarily
12 plutonium, neptunium and technetium were dealt
13 with and the analytical, the statistical
14 analysis was dealt in Appendix F and F-1, and
15 I think you guys have looked at that. And the
16 -- what they did in those tables is they
17 listed the very maximum sample that they ever
18 got and the minimum, and then they had --
19 because of the fact that it was not a standard
20 distribution -- there's wide variation to the
21 sample in all of the process streams. They
22 used the boot strap analysis technique.

1 The reason we settled on 100 parts
2 per billion was -- of plutonium, just using
3 that as the example, was that it covered even
4 the maximum of most of the streams, with the
5 exception of several streams that were
6 identified as the -- what they call the
7 receipt of the POOS on a plutonium over
8 specification.

9 Let me go back a step just for
10 clarification and say that in 1964 they were
11 running short of uranium and they decided to
12 reprocess the plain tower tail from the
13 gaseous diffusion plants for recovery of
14 uranium.

15 Fernald and others objected to
16 that. Whitetail got some of it and they
17 simply buried most of it and sent the rest
18 back, but Fernald did take it with the intent
19 of blending it into the rest of the stock. It
20 doubled the inventory of plutonium
21 specifically in the plant. They got --
22 received two shipments from '64 and another

1 set in the eighties.

2 And so the analyses reported in
3 the Ohio report, by the way, was exhaustive
4 and it covered the highest level of
5 contamination in the plants.

6 When they brought those high level
7 tails from -- they came in as sealed
8 containers and then, of course, they were
9 anxious about them and so they really used
10 very, very careful operating techniques and
11 blended them as soon as they could.

12 It turns out that there were a few
13 barrels, a little bit of it that continued to
14 be on site of those high level tails from the
15 gaseous diffusion plants. I might just add
16 too, parenthetically, that when you convert
17 uranium to the US6 -- uranium US6 at high
18 temperature is volatile. Plutonium is not,
19 and it falls out. Ninety-nine percent of the
20 plutonium falls in those flame tower tails and
21 as a consequence plutonium goes through the
22 gaseous diffusion plant comes back out in

1 parts per trillion as opposed to parts per
2 million, and that's something to kind of
3 remember as you get some of the enriched stock
4 from the plutonium -- from the gaseous
5 diffusion plants.

6 DR. MAURO: Well, I guess -- we
7 talked -- the reason this is coming up is
8 there was this tower ash --

9 DR. NETON: The Paducah Feed
10 Plant ash came in and it was blended, as Bryce
11 indicated, so that none of the production
12 workers were exposed to the concentrations --
13 none of the main production -- uranium
14 production workers were exposed to those
15 levels of concentration.

16 DR. MAURO: At our last meeting -
17 -

18 MR. ROLFES: Most importantly for
19 that data set, for those workers who handled
20 that material, they all participated in a
21 specific plutonium bioassay program, so --

22 DR. MAURO: No, we covered the

1 tower ash very well --

2 DR. NETON: Yes, I thought we had
3 done that.

4 DR. MAURO: Not only that the
5 workers that dealt with that were wearing
6 respiratory protection --

7 MR. RICH: Yes, they were and
8 airline a good share of the time.

9 DR. MAURO: And we're okay with
10 that. That's not the issue.

11 MR. RICH: But what I want to say is
12 that this Table 5 in our white paper is the
13 recycled uranium summary by the process
14 subgroups, and in looking down through there
15 you see a couple of them that are fairly high,
16 but even those are pretty well covered by the
17 100 parts per billion, not the highest values
18 that you'll find in Table F-1 in the Ohio
19 report, but it's -- but for the average
20 process streams --

21 Plus there's -- as a process
22 enriched uranium, it turns out that the

1 majority of the recycled uranium that came
2 into the plant was in the form of enriched
3 uranium. When they actually reduced it to
4 metal in Plant Five, the magnesium fluoride
5 sucked up the plutonium and that was one of
6 the higher process streams. They reprocessed
7 the magnesium fluoride and -- for the recovery
8 of uranium because it was enriched. If it was
9 not enriched it was below economic recovery
10 limits and they disposed of it in the pits.

11 But the magnesium fluoride
12 reprocessing was one of the process streams
13 that showed higher levels, and that would have
14 been run through a mill in Plant One, for
15 example, the Titan Mill, and broken up into
16 particles of a size that could be run through
17 the recovery plant.

18 DR. MAURO: The special cases
19 that you are making reference to, we agree
20 with. But then we -- then we -- part of the
21 mission we received from the last meeting was
22 to look at this boot strap analysis.

1 MR. RICH: Yes.

2 DR. MAURO: Now -- so I'm not
3 disagreeing with anything you're saying about
4 these special cases, so we could -- we agree
5 with that.

6 But then we looked into the boot
7 strap issue--and boot strap means how did you
8 take the data--how did DOE take the data to
9 come up with the concentrations. I'd like to
10 direct your attention to page 23 of our
11 report. I'll give you a chance to open it up.

12 And what we did is we looked at
13 the data. Harry Chmelynski might be on the
14 line; he helped us with this. And we're
15 finding that the data that you had followed
16 along normal distribution, and when we derived
17 the mean of these various groups, 1A, 1B, et
18 cetera, you could see -- if you look at the
19 table there are some rows that are in green.
20 Okay, on page 23 it's -- it's Table A-1, if
21 everyone has it in front of them.

22 And we're seeing a fairly large

1 difference between the mean that we would get
2 versus the mean that is reported, that was
3 derived using what we're referring to as the
4 boot strap method.

5 Now in speaking to Harry about
6 what is this boot strap, it was our -- it was
7 my understanding that this was a way to deal
8 with outliers, and so we see a little bit of
9 a incongruity between the mean that we -- the
10 ratio -- at least with 1-A we get a 5.1 times
11 higher mean, and the same thing goes for 8, 9,
12 and 10-A. We get a substantially higher mean
13 than the boot strap method does, which starts
14 to bring us --

15 Now maybe I got this wrong, but it
16 appears to bring over the 100 parts per
17 billion.

18 MR. RICH: Well, again, let me
19 draw your attention to 10-A is the tower ash
20 and decon residue.

21 DR. MAURO: Okay.

22 MR. RICH: And Group A is -- is

1 the enriched magnesium fluoride that I just
2 mentioned.

3 DR. MAURO: Okay, so you're
4 saying the -- this is important. Now we're
5 getting to the bottom of this.

6 MR. RICH: Yes, so what I'm
7 saying is that we were satisfied that even
8 whatever statistical analysis you used we were
9 pretty well covered with the 100 parts per
10 billion.

11 DR. MAURO: Okay, so what I'm
12 hearing is that the 1-A, 8, 9, 10-A, which
13 where we're getting a mean that's higher than
14 the boot strap mean, the reason is that when
15 you did your boot strap the -- the -- these
16 very special cases that are -- that were--
17 that you described earlier were taken out of
18 the data because it was dealt with separately
19 and under a very controlled circumstance so,
20 therefore --

21 MR. RICH: When we established
22 the 100 parts per billion, John --

1 DR. MAURO: Yes.

2 MR. RICH: -- we considered the
3 fact that those streams, number one -- well in
4 the first place when they did the statistical
5 analysis using the boot strap mean it will
6 come out with different analysis techniques a
7 little bit higher, that's true. But these
8 were processed streams that had an
9 extraordinary amount of care when they were
10 currently being inserted into the dilution
11 system.

12 And so we -- we, frankly, were not
13 worried about those streams because of the
14 fact that they are well known and well
15 controlled.

16 DR. MAURO: Okay, so -- so our
17 derivation of the mean where we included all
18 the data -- we shouldn't have done that.

19 DR. NETON: You can do whatever
20 you want.

21 DR. MAURO: We can do whatever
22 we want. We did that, and for good reason.

1 It answers my question, because quite frankly
2 I didn't understand why we were coming in five
3 times higher, which puts us well over the, you
4 know, one hundred.

5 MR. MAKHIJANI: Well, from what
6 we understood NIOSH did not actually do its
7 own analysis. They used the analysis in the
8 DOE reports which contains this boot strap
9 mean, and that you used the numbers in
10 Appendix F of the Ohio Field office report --

11 DR. NETON: That's correct.

12 MR. MAKHIJANI: -- directly from
13 that. You did not look at the raw data, and
14 you didn't do your own analysis.

15 DR. NETON: John actually called
16 you about that or sent you an email about
17 that.

18 MR. RICH: Yes. We looked at it
19 and considered that, but quite frankly, you
20 know, the majority of the contaminant levels
21 came in less than five parts per billion, and
22 most of it from the gaseous diffusion plant

1 came in under parts per trillion level, but
2 where --

3 DR. MAURO: Okay, when did the
4 first --

5 MR. RICH: -- we dealt with
6 defaulting to the highest reasonable level and
7 without really going overboard in these
8 special streams.

9 MR. MAKHIJANI: When is the first
10 document that we have where we have a
11 measurement of trace contaminants. I mean,
12 this Paducah thing that's on was in the
13 seventies and eighties, and I know there were
14 shipments, there were measurements, there were
15 all these precautions that were taken and, you
16 know, especially in the eighties. I think
17 this Paducah thing was in the eighties.

18 MR. RICH: Right.

19 MR. MAKHIJANI: When is the
20 earliest actual site measurement? Hanford
21 ships recycled uranium. Here's the label.
22 Here is the plutonium that was in it that's in

1 a document from the time.

2 When I looked at Appendix F I saw
3 a lot of surrogate data, data from--assuming
4 that this shipment --

5 (Simultaneous speakers.)

6 MR. RICH: Most of that's from a
7 later period during the higher level period,
8 Arjun.

9 MR. MAKHIJANI: So all --

10 MR. RICH: Pardon me?

11 MR. MAKHIJANI: I'm not aware of
12 early data that's documented that says --

13 MR. RICH: In the early days the
14 -- the responsibility for defining the
15 contaminant concentrations were the
16 responsibility of the shipping sites.

17 MR. MAKHIJANI: And so do we have
18 like a Hanford document that says --

19 MR. RICH: Yes.

20 MR. MAKHIJANI: -- we're shipping
21 X to Fernald.

22 MR. RICH: The 2008 report is

1 some documentation of the historical levels in
2 those early times.

3 MR. MAKHIJANI: Well, speaking of
4 the --

5 MR. RICH: Some of those are
6 summary data.

7 MR. MAKHIJANI: Could we go back
8 on the list of that 2008 report? The 2008
9 report is about recycled uranium that contains
10 trace contaminants. That's what it says on
11 page one.

12 MR. RICH: That's true.

13 MR. MAKHIJANI: And then at the
14 start of chapter three, section three,
15 actually recycled uranium that head appears on
16 every single page, and at the top of page one
17 of section three which I have here -- I just
18 downloaded it. I couldn't find it in my
19 computer.

20 Section three affirms that this
21 chapter is about recycled uranium in the sense
22 that we're talking about it here.

1 MR. RICH: Then I'll go back and
2 say that a report issued by DOE three years
3 later and identified as DOE 2003 corrected the
4 -- well, the primary RU shipments.

5 Now you'll notice in the second
6 sentence it says the transactions into and out
7 of Hanford were focused on the 300-A Pugh
8 Fabrication Complex that were used at all
9 three plants.

10 MR. MAKHIJANI: The first line in
11 chapter says, "This chapter is designed to
12 quantitatively define the recycled uranium
13 flows to and from Hanford. The transactions
14 into and out of Hanford will focus on 300 area
15 fuel fabrication complex."

16 But the whole thing is about
17 recycled uranium.

18 MR. RICH: Initially it was so.
19 It was corrected by the 2003 report.

20 DR. NETON: I mean, Bryce, is
21 there definitive language of the 2003 report
22 that speaks to that?

1 MR. RICH: Yes, the report does
2 speak to that.

3 DR. NETON: I mean, if it does,
4 as a later report, I fail to see why we
5 wouldn't accept that. I mean, we have a 2000
6 report where it's been superceded and there's
7 language in there if we can find it that says
8 that it corrects what was possibly an error in
9 2000. I mean, why --

10 MR. RICH: Initially, when they
11 put out in the 2000 report it was a matter of
12 definition of what constitutes recycled
13 uranium.

14 DR. NETON: I fail to see the
15 argument there.

16 MEMBER GRIFFON: He didn't go
17 back to the raw data because --

18 MR. RICH: No.

19 MEMBER GRIFFON: -- it was too
20 difficult or --

21 DR. NETON: I don't know, Mark,
22 you need to --

1 MR. ROLFES: Once again, I mean,
2 it's a matter of timeliness on re-evaluating
3 data that's already been summarized for us.
4 The bottom line, getting into the recycled
5 uranium issue is really very unlikely to
6 affect a significant number of compensation
7 decisions, if any. Bottom line, we need
8 uranium bioassay data to reconstruct intakes
9 and make a good balanced and professional
10 decision on the information --

11 Go ahead, John.

12 DR. MAURO: I think that -- let's
13 say we're dealing with 100 parts per billion
14 versus 50 versus 200, okay --

15 MR. ROLFES: Right, right.

16 DR. MAURO: Now what happens to
17 the dose, to some of the organs when you
18 change that assumption. I think you have to
19 think of that.

20 MR. ROLFES: It can for certain
21 organs.

22 MR. MAKHIJANI: Moreover, it's

1 not just about plutonium and trying to --

2 DR. MAURO: Yes, we haven't gone
3 there yet.

4 DR. NETON: Let's decide first
5 whether or not we're going to use the fact of
6 this 2000 report that's been superceded as
7 evidence of what the plutonium concentrations
8 were, or we're going to rely on the 2003
9 report that superceded the 2000 report.
10 That's important to me --

11 MEMBER GRIFFON: Yes.

12 DR. NETON: -- and if SC&A
13 opinion that the 2000 report is more accurate
14 I'd like them to show me why the 2003 report
15 is not.

16 MR. RICH: And beyond that, Jim,
17 we have used the 2000 report from Hanford
18 because it's a wealth of information.

19 DR. MAURO: That's right.

20 MR. RICH: My primary correction
21 is primarily in the mass flow data, and, by
22 the way, I'll remind you again the mass of

1 uranium is not at issue so much as the ratio
2 of the material.

3 Now because of the -- the
4 inventory control or the shipment control
5 regulations, they did analyze every -- well,
6 as a matter of fact they analyzed the product
7 from U-plant and PUREX, and any other plant
8 that contributed products to the UO3, which is
9 a uranyl nitrate reduction to UO3 for
10 shipment, and those were all analyzed prior to
11 the point they were accepted by the UO3 plant.

12 If they didn't meet
13 specifications, they sent them back to the
14 extraction box. That was very carefully
15 controlled.

16 DR. MAURO: And that's from the
17 very beginning?

18 MR. RICH: That's from the very
19 beginning, right from the time that they
20 decided to send the first barrel out.

21 DR. MAURO: Which is '61 as
22 opposed to '57 or '58?

1 MR. RICH: That's true.

2 MEMBER GRIFFON: Bryce, just a
3 little background, wasn't there an Ohio Field
4 office mass balance report also? I can't seem
5 to find that one.

6 MR. RICH: Yes, that's the one
7 that we're reporting as being the Fernald mass
8 balance report.

9 MEMBER GRIFFON: Okay, okay.

10 MR. RICH: The Ohio field office
11 report covered RMI, West Valley, a number of
12 other sites in the Ohio Field office.

13 MEMBER GRIFFON: And then I'm
14 trying to remember, but you're very familiar
15 with these reports obviously, but I seem to
16 remember that you said that the shipper
17 usually in the early years especially
18 characterized the contaminants.

19 MR. RICH: That's true.

20 MEMBER GRIFFON: I remember with
21 this ash waste there was a big discrepancy
22 between the Paducah numbers and the Fernald

1 reports.

2 MR. RICH: That's true.

3 MEMBER GRIFFON: How did you
4 weigh -- how did you come down on those?

5 MR. RICH: At that later time
6 period, of course, and because of the fact
7 that they were shipping known higher level
8 contaminant level stuff they analyzed it at
9 both ends, no question.

10 And at that period of time they
11 did more analytical --

12 MEMBER GRIFFON: Well, there was
13 a big disparity in the numbers, and I guess
14 that's my point is -- Jim had asked me why
15 don't we accept the 2003 numbers. Why don't
16 we not go back to the raw data. You know,
17 this is part of my reasoning because I looked
18 at those reports years ago and you have these
19 discrepancies, how do you handle them?

20 MR. RICH: Well, and then the
21 characteristic of those flame tower tails that
22 had accumulated over a number of decades, they

1 were not uniform in and of themselves, and as
2 a consequence there was a -- a considerable
3 amount of variability in the sampling
4 technique itself, and part of those were
5 sampled in -- it was mixed in Plant One.

6 DR. NETON: Right, but I thought
7 the feed plant issue was not necessarily on
8 the table because we recognize it was a
9 separate stream. It was --

10 MEMBER GRIFFON: I guess the point
11 I'm making is --

12 MR. RICH: It was indeed blended
13 down and then analyzed again, but they
14 analyzed the stuff that they got. They were
15 highly concerned about it.

16 MR. MAKHIJANI: Well, the
17 specific numbers that are derived in this boot
18 strap analysis and that are in the white paper
19 are not from the 2003 report, which doesn't
20 contain this information.

21 MR. RICH: No, that's true,
22 Arjun. The numbers are in the Ohio -- or the

1 Fernald report.

2 MR. MAKHIJANI: And those are all
3 from the year 2000 which was part of the same
4 series of recycled uranium analysis that was
5 done in 2000. The later report is 92 pages
6 and it covers a whole nuclear weapons complex
7 and contains almost no detail.

8 The -- all of the detail is in the
9 2000 reports. Now if these 2000 reports were
10 seriously in error to an order of magnitude --

11 MR. RICH: Arjun, let me remind
12 you again the 2003 report corrected only the
13 shipper's numbers.

14 MR. MAKHIJANI: Yes, but all of
15 the concentration numbers, so we're saying
16 that we're going to accept everything in the
17 2000 reports, much of which is surrogate --
18 which are assumed numbers from some other site
19 because individual shipments are not
20 characterized.

21 MR. RICH: Arjun, the numbers
22 were lower as they left the plant, the shipper

1 -- the generating plant --

2 MR. MAKHIJANI: That's not a
3 question.

4 MR. RICH: -- and the numbers in
5 the early years were much lower than they were
6 after -- until -- after the POOS material had
7 been processed from the gaseous diffusion
8 plant.

9 MR. MAKHIJANI: We've seen no
10 early year actual data other than what's
11 reproduced from literally some documents in
12 these reports, which are --

13 MR. RICH: Arjun, admittedly we
14 have accepted the analysis from that extensive
15 -- the data was collected from 1985 to 2000,
16 but it was a major effort by a large team at
17 each of the plants in the year 2000 -- in 1999
18 and 2000.

19 And, no, I have not personally
20 looked at all of the raw data. We -- I talked
21 to a couple of the people, one specifically
22 that served on the team that put that report

1 together at Fernald. He says as far as he
2 knows the raw data is available. He's not
3 sure where it is, but it probably would not
4 have been disclosed.

5 MR. ROLFES: The bottom line is
6 what -- what sort of impact will this have on
7 a dose reconstruction. And I think that's
8 what we need to keep in mind.

9 You know, we have different types
10 of approaches for dose reconstructions. If an
11 individual has uranium uranalysis we would use
12 that uranalysis to calculate an intake , for
13 example, for lung cancer.

14 If that claim were still under 50
15 percent probability of causation, we would
16 also consider other sources, other potential
17 intakes, for example thorium. We would apply
18 intakes for thorium. If it was
19 still under 50 percent we would consider other
20 sources such as radon. If it was still under
21 50 percent I don't know what else we can do to
22 put it over 50 percent. It gets to a point,

1 you know -- we can also take a look -- we are
2 already accounting for recycled uranium
3 components, the radiological contaminants that
4 were sent in back to Fernald from the reactor
5 sites. We're taking a look at that.

6 There was a requirement in the
7 early days to maintain plutonium contamination
8 levels under 10 parts per billion on a uranium
9 mass basis. We've defaulted to an order of
10 magnitude higher.

11 DR. MAURO: No, no, no. The 10
12 part per billion was what was shipped from
13 Fernald to other sites. But Fernald was
14 processing the material. The 100 parts per
15 billion is -- is what we're -- is what's on
16 the table here. In other words, is that a
17 good default number for your recycled uranium.

18 The process by workers at Fernald
19 from 1961 onward --

20 MR. ROLFES: Right.

21 DR. MAURO: -- and the reason --
22 well, there are a couple of reasons this issue

1 emerged. One is the boot strap. That was
2 explained. In other words, when we wrote that
3 boot strap was data. And we came up with a
4 number that was five times higher.

5 So there's an answer. The answer
6 is oh, no. When we did the boot strap we
7 didn't include these extreme values because
8 they were treated specially.

9 MR. CHMELYNSKI: John, can I
10 interrupt a second?

11 DR. MAURO: Yes.

12 MR. CHMELYNSKI: You keep saying
13 we did it, but we didn't. All we did was
14 quote what DOE has in that report. It has in
15 that report the numbers you need to fit the
16 log normal distribution and to report the log
17 normal results. It also has the boot strap
18 analysis.

19 MR. RICH: And the data is
20 plotted graphically as well as -- so, you
21 know, it's a complete report.

22 MR. CHMELYNSKI: All we're

1 pointing out are some -- perhaps discrepancies
2 or different answers that are obtained using
3 the two methods.

4 DR. NETON: Right, and I think
5 that the bottom line is still the same as John
6 indicated though that there are reasons why we
7 went with 100 versus using the entire set of
8 data because of these special campaigns that
9 were processed.

10 So I think that's okay. I'm
11 hearing more fundamental distrust by SC&A of
12 the things they feel they have some need to go
13 back and look at the actual raw data set that
14 exists, and, frankly, I don't know if we can
15 find it and how much work that would be to
16 obtain that.

17 MR. ROLFES: Getting back, you
18 know -- literally there's a small population
19 of claims that this, once again, is going to
20 be applicable to because if we have a claim
21 that hasn't achieved 50 percent probability of
22 causation using intakes reconstructed from

1 uranium, from thorium, from radon, from
2 medical x-rays, from external exposure -- you
3 know, one additional thing which, you know,
4 we're arguing over something that really is
5 not going to be a significant -- you know,
6 alone it is if we are solely using that as the
7 basis for dose reconstruction; however, there
8 are many other sources of other information
9 where there are more, you know, more first-
10 hand information, more likely exposures, for
11 example, to uranium than a contaminant that a
12 worker may not have been exposed to, and not
13 at the level that we've assumed in our
14 technical basis document.

15 We have additional sources of
16 bioassay data to use that we could reconstruct
17 someone's plutonium intake for -- for the POOS
18 material, the out-of-specification material,
19 but what I guess I'm getting to is the
20 assumptions that we make in a dose
21 reconstruction--off the bat when we interpret
22 someone's urinalysis data we assume a

1 constant chronic day-in, day-out exposure
2 using that individual's bioassay data or
3 reconstruct that uranium intake.

4 Then many of the other cases, for
5 example, as we have pointed out for, you know,
6 for 40 percent of the cases that we've
7 completed -- excuse me, 40 percent of the dose
8 reconstructions that we've completed for
9 Fernald have been compensatory. Largely,
10 those decisions are based on the individual's
11 uranium bioassay data or the individual's
12 monitoring data.

13 The cases that we have not been able to
14 get over 50 percent probability of causation,
15 we've thrown worst case scenarios which
16 exceed, you know, exceed the credible amounts
17 of uranium that could have been ingested,
18 inhaled, critical amounts of thorium --

19 DR. MAURO: I understand, but,
20 Mark, what you're really saying is that the
21 assumption regarding 100 parts per billion of
22 thorium is irrelevant, and, you know, it's

1 not.

2 MR. ROLFES: It's not irrelevant,
3 but it's not going to have a large scale, huge
4 impact on a significant number of claims.
5 We're talking about a very, very few claims
6 today. The entire -- the past, you know, the
7 past several working group meetings, we're
8 talking about a very, very small fraction of
9 the Fernald work force that were potentially
10 exposed to some of these what-if scenarios.

11 We're talking about very, very low
12 odds of people being exposed to, you know --

13 DR. NETON: Yes, Mark makes a
14 very good point. I mean, we were very
15 conservative in our approach in being claimant
16 favorable, but to get past this we have to
17 decide whether there is a credible scenario
18 that exposes workers at Fernald to greater
19 than 100 parts per billion on a continuous
20 basis outside of these areas that we
21 identified as special campaigns.

22 That's the bottom line, and if

1 SC&A believes that it's well above 100 parts
2 per billion and demonstrates that somehow we
3 need to look into that.

4 DR. MAURO: We can't We can't
5 demonstrate that.

6 MR. MAKHIJANI: Is that the right
7 question? The -- I think for some of these
8 batches, including some of the very high ones,
9 we do have data, and I think whatever number
10 you come up with there's some defensible
11 number of doses that you could come up with,
12 and it can be claimant favorable, assuming
13 there's no supply there.

14 DR. NETON: Right.

15 MR. MAKHIJANI: There are a
16 number of issues that that question doesn't
17 cover. If you look at what happened in the
18 1950s at Hanford, which was the original site
19 for recycled uranium, it was qualitatively
20 different than what happened in the sixties
21 and seventies in terms of how the recycled
22 uranium originated.

1 At Hanford in the fifties, as you
2 know, they started the U-plant operation in
3 1952, and that's sort of like a raffinate
4 problem. It has -- all the plutonium had
5 already been extracted from it. So you have -
6 - you're processing a mixture of uranium and
7 fission products first of all, so the whole
8 question of whether plutonium is a key
9 radionuclide on which to hang your hat for all
10 the other trace contaminants is a very
11 relevant one.

12 I don't think that plutonium is a
13 key radonucleide, and that's one reason --

14 DR. NETON: Dosimetrically, I
15 think it is.

16 MR. MAKHIJANI: What?

17 DR. NETON: I think
18 dosimetrically it probably is. I mean, I
19 looked at it --

20 MR. MAKHIJANI: Well, it depends
21 on the relevant amount, say, of plutonium you
22 have, relative to --

1 DR. NETON: Yes, go ahead.

2 MR. MAKHIJANI: In any case, you
3 have a process difference which means that
4 something that was part of a reprocessing
5 operation where uranium and plutonium are
6 being separated from each other after the
7 fission products have gone. And in the
8 earlier period where uranium efficient
9 products are being separated from each other
10 after the plutonium is gone. I mean, there
11 are traces of everything that are left,
12 obviously, but in the main.

13 So that sort of one whole set of
14 questions that arises from that is do we have
15 any data from the Hanford shipments of U-plant
16 uranium and what was in it.

17 MR. RICH: Arjun, can I respond
18 just briefly?

19 MR. MAKHIJANI: Sure.

20 MR. RICH: You're going to make a
21 chemical processing -- the initial plant's
22 business was separation, which was not a

1 liquid column separation. It was a -- it was
2 a settling operation --

3 MR. MAKHIJANI: In-tank systems

4 MR. ROLFES: -- multiple
5 processors. Then they went to a hexone
6 system, which is a liquid-liquid column
7 extraction system. That's the second
8 generation system, and they were using that
9 plant to separate both plutonium and uranium,
10 when they decided that indeed they needed the
11 uranium.

12 During the period of time from '47
13 to when they started in 1951, they stored the
14 raffinate -- the uranium with the raffinate,
15 and they refit U-plant with a third generation
16 chemical separation which was TBT in an
17 organic kerosene base. And that plant was
18 PUREX, and it was the best that technology
19 could provide and as determined by the DS for
20 -- it cleaned up plutonium and uranium as well
21 as could be done. That was the best
22 technology available.

1 I started in '53 at the chem
2 plant, and that was a hexone based system.
3 They gradually changed it to PUREX. But the
4 U-plant was the third generation uranium
5 extraction system. They extracted the uranium
6 in a slurry form out of the tanks. It had
7 separated into a slurry and an aqueous stream
8 and 72 percent of uranium was in the slurry.

9 The chemical processing for U-
10 plant was the best technology that was
11 available. It was a third generation. They
12 blended that with the other plant, not the
13 PUREX plant but the other plant, and the
14 products were, again, analyzed as being
15 acceptable to -- for feed for the UO3 plant.

16 There's no reason to believe that
17 the U-plant process was incapable of providing
18 the best separation of any of them, and so as
19 a matter of fact I think they planned it for -
20 - because it was good stuff and the other
21 plant was -- the second generation plant was
22 not so good.

1 So that also is a -- but, again,
2 the -- the product for UO3 plant met specs and
3 based in the very early days on gross beta and
4 gross gamma for others than the plutonium.

5 And so I would say that even in
6 the very earliest days they had a very good
7 handle on the contaminant levels.

8 DR. MAURO: We've changed
9 subjects, and that's good. I think that we've
10 exhausted our discussion on 100 parts per
11 billion, okay? We know where that is. What
12 we've just done is say what about the other
13 radio nuclides, because now we're saying that
14 there are a lot of different ways in which the
15 uranium was separated and processed.

16 MR. RICH: And my comments were
17 directed directly to that.

18 DR. MAURO: I just wanted to make
19 it clear that we changed subjects. And that's
20 good, because I wanted to move to this other,
21 which now means the neptunium, the technetium,
22 thorium 232, ruthenium, these are the other

1 assumptions that are embeded.

2 Now I think what we've heard is
3 that there is not a tight couple between the
4 ratio of plutonium, neptunium, so it's not as
5 if, you know, you would expect the
6 relationships here to be labile.

7 What I mean by that is these
8 ratios have been selected by NIOSH under the
9 premise that it is -- represents a fairly
10 bounding set of assumptions. We heard your
11 arguments regarding 100, and I guess we really
12 don't have -- I mean, I understand them now.
13 And so it's on the table. Everybody
14 understands the story, and I guess I don't
15 feel there's any more I can add to it than
16 what's already been said.

17 Now we're talking about these
18 other radionuclides. Now what I just heard is
19 that the separations process, the chemistry
20 that we use, the columns changed over time
21 which affected, I presume, the composition of
22 the trace levels of various fission products

1 that were actually, some of these, activation
2 products in that the eluent came off the
3 separations.

4 Do you have data -- I mean, what
5 I'm hearing is there were specifications, so
6 the product that came out before it was
7 shipped from Hanford -- these particular
8 numbers that we're looking at, the 3,500 parts
9 per billion neptunium, and let's go to
10 ruthenium, which is 50 microcuries per pound
11 of uranium.

12 Those -- those are -- are those
13 the specifications? Are those measured values
14 for various campaigns. In other words, you're
15 obviously convinced that those are good
16 numbers.

17 MR. RICH: Those numbers, John,
18 are the -- based on the specifications, the
19 maximum specifications that can be shipped for
20 the fission product, you know the gross
21 contaminants that would give you a gross beta
22 or a gross gamma, you know, the strontium-90

1 or the cesium-137 or other longer lit fission
2 products which would be the isotopes of most
3 concern.

4 DR. MAURO: Well, we don't
5 actually have like records of the actual
6 measurements made.

7 MR. RICH: We do have after a
8 period of time. I forget right now. I don't
9 have the date, but they did ship from a -- a
10 gross beta, gross gamma measurement with a --
11 they used a Shonka chamber to begin with, but
12 then they switched to -- when -- again when
13 the spectrometer became available then they
14 shifted instead of the gross gamma to a
15 spectrometer measurement in which they
16 measured the specific isotopes.

17 DR. MAURO: You know, when we
18 typically do a job like this, what we do is go
19 back to the original data and we convinced
20 ourselves, yes, it looks like we sampled from
21 the data. We looked at some data from
22 different campaigns, perhaps different time

1 periods and look at the results of the
2 analysis of the material and say, yes, it
3 looks like across the board these numbers are
4 holding up.

5 We're really not in a position to
6 do that. So what we're really doing is
7 accepting our fate that yes, DOE, you know,
8 did rigorously enforce that specification and,
9 if that's the case, that's the case.

10 It's just an unusual circumstance
11 here where we're sort of taking it on faith
12 that those specifications were met, and we're
13 not really in a position on behalf of the work
14 group to go into the original data and
15 convince ourselves, yes, it looks like that
16 was universally the case.

17 MR. RICH: Some of that data is
18 contained in the DOE 2000 and the 2000A report
19 for Hanford Mass Balance Report, also in the
20 Hanford Technical Basis documents.

21 DR. MAURO: Yes, I have nothing
22 more to add.

1 MEMBER GRIFFON: I'm not sure
2 where we take this at this point. I mean, I
3 did -- I did pull up the Paducah report while
4 we were sitting here and this is sort of what
5 I had remembered the -- it's on Table 4.2-2 in
6 the Paducah mass balance report.

7 And it says 1980 feed plant ash
8 average plutonium concentrations in parts per
9 billion and was 37 to 3,118. And these are
10 the results from 16 hoppers analyzed by FMPC,
11 so I guess that was sort of the Fernald
12 analysis.

13 But you're saying this is that --

14 DR. MAURO: The special case.

15 MEMBER GRIFFON: -- special case
16 that's --

17 MR. RICH: Yes, and that's very
18 typical of that type of material that came
19 from all of the gaseous diffusion plants.

20 MEMBER GRIFFON: Right, right.

21 MR. MAKHIJANI: What is the date
22 of that?

1 MEMBER GRIFFON: This is the mass
2 balance Paducah report --

3 MR. RICH: It's a 2000 --

4 MEMBER GRIFFON: 2000, yes.

5 MR. MAKHIJANI: The data that's
6 sampled?

7 MEMBER GRIFFON: Oh, the data
8 that's sampled? It's summarizing the 1980s,
9 so I imagine --

10 MR. MAKHIJANI: You know,
11 actually, the SC&A report said that beyond a
12 certain date -- and I would suspect, I don't
13 know, probably somewhere in the 70's or
14 whenever from the time that we had these kinds
15 of numbers based on measurements at the time,
16 we can actually trace it that the stated
17 ratios are probably claimant favorable for
18 long-term workers when applied, et cetera.

19 The report actually says that.
20 The questions are when you don't have that
21 kind of information and you have lots of
22 surrogate data, you have process differences

1 in how the plutonium was arising. You have
2 differences, possible differences in ratios of
3 the plutonium fission products, plutonium,
4 neptunium, and so on.

5 If you look at the stack analysis
6 that was done of the stack data that is in the
7 white paper and you look at that, you see some
8 stacks have pretty much fission products.
9 Some stacks have, other than the plutonium,
10 very little fission products, and this is a
11 cumulative thing from 30 years.

12 MR. RICH: But, Arjun, what we've
13 done from a philosophical standpoint is take
14 a -- we used the data from the highest
15 contaminated years.

16 MR. MAKHIJANI: So even if you
17 look at the stack data, the analysis that's
18 done in the white paper shows, you know, if
19 you include the Titan Mill sample, which is
20 after all a cumulative sample which was
21 excluded from the white paper analysis, then
22 you come up with a part per billion of

1 plutonium of more than 100 in an average,
2 which is a cumulative average.

3 Now you could only come up with 14
4 ppb if you exclude the really high number.

5 MR. RICH: Now, Arjun, let me --
6 let me just tell you again. We included the
7 effluent filter data primarily as an
8 indication that, in a gross way, that the
9 levels were not off by --

10 MR. MAKHIJANI: That's right.

11 MR. RICH: -- several orders of
12 magnitude.

13 MR. MAKHIJANI: Yes, I
14 understand.

15 MR. RICH: We did not use those
16 numbers because of the fact that there is such
17 a great deal of uncertainty associated with
18 the finding those as being streams to which
19 the workers are exposed.

20 MR. MAKHIJANI: Right, I
21 understand that it's a kind of confirmatory
22 exercise that you actually didn't use those

1 numbers.

2 MR. RICH: And as a consequence,
3 Arjun, we did not feel that even the Titan
4 mill, which was a process equipment and not a
5 sampling equipment that -- that that number
6 was higher, obviously higher than it
7 invalidated the -- the other -- to make a
8 conclusion.

9 MR. MAKHIJANI: Well, whether it
10 did or not as a validation exercise or a
11 confirmatory exercise is more iffy than what
12 was presented in the white paper.

13 MR. RICH: But you see that that
14 was, you know, one or two samples in a whole
15 bunch taken across the plant, and if you're
16 not going to use that to establish your ratio
17 then, of course, this is a validation that the
18 numbers are not too bad.

19 DR. NETON: Let me ask a silly
20 question, I suppose. When Fernald was making
21 uranium, I mean, we're assuming they would
22 have 100 parts per billion plutonium in their

1 feed stock on a continuous basis.

2 DR. MAURO: Starting in '61.

3 DR. NETON: Starting in '61. But
4 the majority of the uranium that they
5 manufactured did not come through the
6 recycling room; is that correct?

7 MR. RICH: That's true

8 DR. NETON: We have assessed
9 what that ration is? I mean, in other words,
10 you know, we're just assuming --

11 MR. RICH: During the maximum
12 time that they were processing the high level
13 feed from the tails from the gaseous diffusion
14 plant, on occasion they did bump up against
15 the 10 parts per million in products that they
16 sent out.

17 DR. NETON: And that's sort of my
18 point I guess is, you know, we've got an input
19 term here we're trying to wrestle with. I
20 mean, was it 100 parts per billion, was it
21 more than that.

22 But we're also--they blended this

1 this stuff -- it's a small fraction of the
2 total product being produced to begin with, so
3 it's assumed to take these pure numbers and
4 assume that the workers were exposed only --
5 essentially to recycled uranium is ludicrous.

6 MR. RICH: Though I'm convinced
7 in my own mind that we're -- we've very
8 conservative, at least by a factor of 10 for
9 99 percent of a worker population.

10 DR. NETON: It seems incredible
11 to convince myself at least that the workers
12 were chronically exposed to 100 per parts per
13 billion plutonium throughout the life of the
14 plant from '61 on.

15 DR. MAURO: As I opened up,
16 remember we're always confronted with these
17 problems and it's any aggregate. We don't
18 have a big question. And what we really was
19 probe, when I went with the boot strap -- the
20 ratio of the boot strap, I said there's
21 something here that doesn't ring true.

22 But I did know that there was a

1 special case with the tower ash, and it sounds
2 like there were other special cases. There
3 were a few special cases.

4 DR. NETON: There were a few
5 excursions that were known in his --

6 DR. MAURO: Right and the reality
7 of the situation is if all of those special
8 cases were well in hand, then the boot strap
9 method makes sense because you don't want to
10 include those special cases because you used
11 respiratory protection when they were handled.

12 So, I mean --

13 DR. NETON: When the workers were
14 monitored for plutonium?

15 DR. MAURO: And they were
16 monitored. So I guess, you know, in light of
17 that, I mean, I have nothing more to say. It
18 sounds like you make a pretty compelling
19 argument for the 100 possibility.

20 I'll leave that up to the work
21 group to make their own judgments. Well, we
22 have nothing more to add.

1 The other has to do with the mix
2 of fission products and whether or not that
3 mix is -- of fission products--which is really
4 separate because they're not linked.

5 Am I correct that the plutonium
6 composition of the uranium and the other radio
7 nuclides are not necessarily linked because of
8 the way in which the uranium was purified by
9 different methods at different times?

10 CHAIRMAN CLAWSON: That's true
11 but we have sort of a default mixture that is
12 developed -- the fission product contaminants
13 were not developed as a ratio to the amount of
14 plutonium, I don't think.

15 DR. NETON: I don't hear Bryce
16 saying.

17 DR. MAURO: I've been thinking
18 that, to tell you the truth.

19 MR. RICH: That's -- that's true.

20 DR. NETON: So you're incorrect.
21 You have to have some kind of value to use.
22 It's not -- this much plutonium there for

1 assuming this much fission products.

2 DR. MAURO: And throughout --

3 MR. RICH: And, again, for the
4 inner isotopes, other than the ones that were
5 -- yes, the transuranics, we used the maximum
6 levels that were allowed to be shipped to the
7 plant.

8 MR. MAKHIJANI: And for the --
9 and for the fission products?

10 MR. RICH: Those were the fission
11 products.

12 DR. NETON: Again, you've got the
13 question do they follow their own guidelines.
14 I've taken the maximum value, meaning clearly
15 there were shipments that were less than that,
16 and we tried to bound them using whatever they
17 could maximally allow.

18 MR. RICH: Most of them were less
19 than that, but a considerable amount.

20 DR. NETON: Right. So we've got
21 another level of conservative --

22 DR. MAURO: So what you're saying

1 is that it's very unlikely -- what I'm hearing
2 is that the argument is, you know, even though
3 our intent is to protect -- make sure that all
4 workers when we reconstruct doses that we feel
5 confident that we've -- have either a
6 realistic or a bounding estimate of what their
7 dose is, and the argument being that even
8 though there might have been some short
9 periods of time where you could have been
10 high, in the long term maybe you'll request a
11 year or more, it's unlikely that anyone's even
12 going to approach these concentrations of dose
13 periods.

14 MEMBER ZIEMER: And especially
15 all of them all the time.

16 DR. MAURO: Especially all of
17 them all the time.

18 MR. RICH: And the other thing to
19 keep in mind too, the same products are
20 probably about three orders of magnitude less
21 in hazard level than the transuranics.

22 MEMBER ZIEMER: In terms of dose

1 per unit activity, Bryce --

2 MR. RICH: That's what

3 DR. MAURO: But of course the --

4 MEMBER ZIEMER: That's true for

5 most organs, not in every case but --

6 DR. NETON: The orders of

7 magnitude, you know, I've done these

8 calculations and they contribute very little

9 to the overall dose compared to things like

10 plutonium.

11 DR. MAURO: Plutonium is the

12 driver.

13 DR. NETON: It tends to be more

14 uniformly distributed in the body --

15 DR. MAURO: I've got to say, I

16 have nothing more to offer. Arjun, is there

17 any more?

18 MR. MAKHIJANI: No, I think, you

19 know, we're kind of discussing the -- in

20 effect, we're discussing the paper that's in

21 review in -- in ORAU NIOSH, and, you know, I

22 have nothing more. I mean, it's really to the

1 working group as to where we go from here.

2 CHAIRMAN CLAWSON: Well, I think
3 -- I first of all have got to see what -- see
4 a white paper that NIOSH is sending us in
5 response to them before we can go on.

6 MEMBER ZIEMER: Well, I think
7 we've heard the points. Maybe we have to
8 formally close it out.

9 DR. MAURO: Yes.

10 MEMBER ZIEMER: It appears that
11 the practical impact is going to be pretty
12 small -- of these issues. I mean, I think
13 these are some valid issues -- whether they
14 impact.

15 But what is it we need to decide
16 with respect to recycled uranium, whether or
17 not NIOSH has effectively --

18 DR. NETON: I would offer that it
19 might be crucial to review the document that
20 we submit. I mean, it might have some nuances
21 in there that haven't been captured in this
22 discussion.

1 CHAIRMAN CLAWSON: Well, and it
2 might bring to light some of the confusion one
3 way or another, because we saw this early on
4 about the recycled uranium back and forth like
5 that --

6 MEMBER GRIFFON: I don't think
7 that there's any more actions, but I'd like to
8 look. I'm not ready to vote and say close.
9 I think we've -- I've got the arguments. I
10 want to see the paper --

11 CHAIRMAN CLAWSON: That's fine.

12 MEMBER GRIFFON: -- and look at
13 some of the background data a little more and
14 maybe a few follow-up questions but no
15 actions.

16 I mean, I still -- I'm going back
17 to that Paducah/Fernald stuff, and it's not
18 only the fact that there was this range
19 reported which is very wide, but it's also
20 that -- and I couldn't find it but I'm pretty
21 sure that the Paducah side of the -- of the
22 House Sample of these same things and have

1 very different numbers than the Fernald side.

2 DR. NETON: But again those --

3 those --

4 MEMBER GRIFFON: I know.

5 DR. NETON: -- the 10 parts per
6 billion in process streams.

7 MEMBER GRIFFON: They're blended
8 by someone, I imagine.

9 MR. ROLFES: Does it --

10 MEMBER GRIFFON: I guess in my
11 mind -- I guess for me it also raises the
12 question of well how solid are these other
13 numbers that were assuming are accurate. Are
14 they heterogeneous streams, are they -- you
15 know, I don't know.

16 MR. ROLFES: It would only matter
17 when you get bioassay data to reconstruct
18 intakes of plutonium.

19 MR. MAKHIJANI: A couple of
20 things you might consider -- I mean, looking
21 at all the stuff and hearing what Bryce has
22 said and what's in process, I think there are

1 no data from the early period that I've seen
2 in terms of, you know, if the shipping site
3 was responsible for, say, we're within the
4 specifications and here are the measurements.
5 Here's what we did. Here's what's on the
6 barrel. It would be--presumably some
7 documentation was generated. Undoubtedly, it
8 was generated when there were inter-site
9 shipments, and it really would be useful to
10 have at least some kind of documentation.

11 The other thing that I think we
12 didn't focus on. I just want to call your
13 attention to it to see if you want to consider
14 it and do anything about it.

15 If you look at the parts per
16 billion data in the Ohio Field office report,
17 a lot of them are surrogate data, that go into
18 these average numbers that have been
19 incorporated into the white paper.

20 Their data from other -- you know,
21 we assume that this Paducah shipment was like
22 this Oak Ridge, and if you look at the report

1 very large numbers of samples have -- the
2 identical--9.16, 0.2, 412.77--because they
3 have no data on those shipments.

4 Now I know we're looking at
5 surrogate data in a different circumstance,
6 but this is a real life practical example
7 where you've got a surrogate data question
8 that -- at least I want to point out that it
9 is there, and it is pointed out.

10 MR. ROLFES: I'm not sure I
11 follow what the numbers you were citing were,
12 Arjun.

13 MR. MAKHIJANI: Well, if you look
14 at the Ohio Field office report, Mark, in
15 Appendix F where are a lot of these numbers
16 are developed and the boot strap analysis was
17 done and so on, you'll see that not every
18 stream with their numbers has its own
19 measurements, but it assumes that some streams
20 of recycled uranium are like some other
21 streams of recycled uranium for which there
22 are data, and I'll try to pull up an example.

1 MEMBER ZIEMER: Streams from
2 elsewhere?

3 MR. MAKHIJANI: Streams from
4 elsewhere.

5 MEMBER SCHOFIELD: They're giving
6 them generic numbers?

7 MR. MAKHIJANI: Not generic
8 numbers, they're giving numbers from some
9 known stream where it was measured.

10 MEMBER ZIEMER: And the surrogate
11 data issue is one where for the number to be
12 accepted there has to be a fair bit of
13 similarity between the processes including the
14 operation, the masses--the process.

15 MR. MAKHIJANI: And one of the
16 points I think to consider, the DOE exercise
17 was a mass balance exercise. It wasn't a dose
18 reconstruction exercise. It wasn't an
19 exercise to see something has to be claimant
20 favorable. It was, you know, what happened
21 and where did this recycled uranium come from.
22 Do we have a grip on the order of magnitude of

1 the flow of the tranuranics.

2 MR. RICH: Arjun, could I just
3 correct you on one minor point there?

4 MR. MAKHIJANI: Sure.

5 MR. RICH: The mass balance
6 report was chartered with the objective of
7 creating the data necessary to determine what
8 the impact on the workers was. It was not
9 specifically to do a dose reconstruction, I
10 admit, but it was generated with the idea that
11 it would provide the data to determine what
12 the impact from a dose standpoint was on the
13 workers.

14 CHAIRMAN CLAWSON: Well, I think
15 that this is great, but I think I'd like to
16 take just a 10-minute break right now, if that
17 would be all right with everybody.

18 MEMBER ZIEMER: The action is
19 that we'll review the NIOSH white paper.

20 CHAIRMAN CLAWSON: Right, we're
21 going to review the NIOSH white paper.

22 DR. NETON: We need to deliver

1 it.

2 MEMBER GRIFFON: I guess we
3 should have SC&A formally look at that white
4 paper, so when we say we --

5 MR. RICH: I might just add one
6 more thing. We do have an OTIB 53 which deals
7 with recycled uranium in a general sense
8 throughout the complex. That's being held up
9 right now, but --

10 DR. NETON: It's in review.

11 CHAIRMAN CLAWSON: Okay, could we
12 just take about a 10-minute comfort break?
13 Would that be all right?

14 MR. KATZ: All right, so about a
15 quarter of we'll start back up. I'm going to
16 put the phone on mute, but we're not breaking
17 the line.

18 (Whereupon, the above-entitled
19 matter went off the record at 3:35
20 p.m. and resumed at 3:50 p.m.)

21 MR. KATZ: Folks on the phone,
22 this is Ted Katz again with The Advisory Board

1 on Radiation and Worker Health, Fernald
2 Workgroup, and we're just starting back up
3 after a brief break.

4 CHAIRMAN CLAWSON: I guess first
5 of all I just wanted to clarify that at the
6 conclusion of our last conversations we were
7 going to have SC&A review the NIOSH white
8 paper that's coming out on the recycled
9 uranium issue. Was there any other thing that
10 we had, Paul, or that was it; wasn't it?

11 Okay, and I'll turn the -- John,
12 we've got a couple of them here. Which one
13 did we want to go to next?

14 DR. MAURO: Yes, well, we've got
15 two, and it would be nice if we could do each
16 within about 20 minutes to a half hour. And
17 the two subjects we have left are -- one has
18 to do with the radon releases from the silos.
19 In a nutshell, we wrote a white paper that
20 everyone should have, but it has not been PA
21 cleared, dated November 25, 2008. Hans
22 Behling did the work. The bottom line is

1 we're coming up with sources, radon emissions
2 from the silos, that are 60,000 to 90,000
3 curies per year. NIOSH and their folks have
4 recently issued a critique of our work dated
5 February 2009 by Sam Chu, who disagrees with
6 us and gives his reasons.

7 We reviewed that. We disagree
8 with him. We think our numbers are right and
9 NIOSH's numbers are wrong, and Hans Behling
10 will explain why, but before we do that, I
11 just want to let you know we also have John
12 Stiver with us today. John is a CHP with us
13 and joined our organization about --

14 MR. STIVER: About six weeks ago.

15 DR. MAURO: -- about six weeks
16 ago. And John -- I asked John to look into
17 this -- by the way, both the subjects we are
18 going to cover were authorized by the last
19 work group meeting, namely they asked us at
20 that time -- from the last meeting -- Hans
21 gave a brief description of work he did, and
22 we were asked to make it a formal white paper,

1 which is exactly what this document is.

2 The other thing we were asked to
3 do is to look into the Thorium-232 DWE, daily
4 weighted exposure data, and the breathing zone
5 data, general air sampling data that's going
6 to be used by NIOSH to reconstruct inhalation
7 exposures to Thorium-232. We are -- we
8 haven't prepared a report; however, John has
9 done a lot of work in looking at the landscape
10 of the data, the records, what do they look
11 like, and he has a number of talking points
12 and handouts just to give you a briefing of
13 the status of our investigations into that
14 matter.

15 With that, I'd like to turn it
16 over to Hans. Hans, are you on the line?

17 DR. BEHLING: Yes, I am. Can you
18 hear me?

19 DR. MAURO: It's called an
20 alternative assessment of radon releases from
21 K-65 silos, an SC&A white paper. The cover
22 page says November 2008 on it. The actual

1 footer, though, gives a specific date of
2 November 25, 2008. This document of course
3 went through DOE clearance, but it has not yet
4 been PA cleared. It is in the process of
5 being PA cleared.

6 Hans, it's all yours.

7 DR. BEHLING: Okay. Again, I'll
8 just quickly go through a couple of historical
9 issues. This really refers to -- this report
10 reflects Finding Number 4.2-3, which was a
11 finding that we identified as part of our
12 review of the SEC petition, and of course,
13 NIOSH's evaluation report.

14 In that petition -- in that review
15 of our petition, we processed the assessment
16 of the radon emissions from silos one and two,
17 which were estimated at 5,000, 6,000 curies
18 per year, might have been less than what we
19 thought it should be.

20 And as part of our review, I
21 concluded that perhaps as much as 60 to 90,000
22 curies per year might be the appropriate

1 value, and as a result of that finding, it was
2 the work group who had asked SC&A to go back
3 and support that revised estimate, and this is
4 what this particular report is trying to do
5 here.

6 Most of -- in fact, the -- the
7 estimate of 5,000 to 6,000 curies per year for
8 radon releases that was defined in the site
9 profile for Fernald are really values that
10 were derived from a 1995 report issued by John
11 Till, the RAC Report. And it was really not
12 NIOSH's calculation, but it was a reference to
13 an early 1995 report by John Till that
14 identified that particular number.

15 Now in going over my reassessment,
16 I looked very carefully at the 1995 RAC
17 Report, and I'm probably going to be quoting
18 certain portions of that as part of this
19 review.

20 One of the things that -- for
21 those of you who are in a position to actually
22 look at the hard copy of the report, either

1 hard copy or on the computer screen, I would
2 ask you to turn to page three, which contains
3 Table One in my report, and the title of that
4 report is Summary of Historical Changes to the
5 K-65 storage silos.

6 And again, this comes from
7 Appendix J of the RAC 1995 Report. And
8 there's a couple of dates that I want you to
9 keep in mind. From the very beginning, there
10 was construction defects in those silos, and
11 everyone knew about it, and over a period of
12 time they attempted to make corrections. But
13 the major correction occurred, if you look at
14 Table One, at the end of June of 1979 where
15 the openings in silo domes, including the
16 gooseneck pipes and other penetrations, were
17 sealed with gaskets and installed to prevent
18 radon emissions.

19 Additional modifications to the
20 silos occurred in '83, '86, and another number
21 or date that I want you to recall -- remember
22 is the radon treatment system -- the year that

1 it was installed in 1987. And the purpose of
2 that radon treatment system I will explain a
3 little later on, but for the moment it was
4 there to basically vent the head space in the
5 silos from radon, and reduce the dose rates on
6 top of the dome so that workers could work
7 there, and an acceptable dose rate would
8 result from having vented the head space.

9 And of course in 1991 there was
10 some measurements taken from the matrix of the
11 raffinates, and that's the thing that I'm
12 going to talk about next. I'm going to refer
13 you to Table Two in my report. That occurs on
14 page seven.

15 And the key thing that you need to
16 understand is the disequilibrium between
17 Radon-226 and Lead-210. If you look at Table
18 Two, and this is a 1991 sampling that was
19 done, and you will see a whole series of rows
20 that go from left to right, and in the second
21 column you will see the zone, and the zones
22 represent the depth of the raffinate matrix.

1 If you're looking at Level A,
2 that's very near the top, if you're looking at
3 B that's sort of in the middle, and C is
4 towards the bottom.

5 But for the moment, to keep things
6 short, if you look at the actual value of the
7 mean for silo number one, and I highlighted or
8 I enclosed the columns for Lead-210 and Radon-
9 226, you will see for Lead-210 the average
10 value, the mean value was 194,000 versus
11 525,000, and that gives you an equilibrium
12 ratio of 37 percent -- or ratio of 37 percent,
13 which clearly says that we're not in
14 equilibrium.

15 The same thing for silo number
16 two. If you look at the bottom, you will see
17 123,000 versus 209,000, and that is also a 38
18 percent level of equilibrium between those two
19 radionuclides.

20 Those values are again repeated in
21 summary fashion in table four on page six, and
22 as well as on table five is some additional

1 data from 1993 which tends in part to support
2 the earlier '91 data, with the exception that
3 silo two has a much higher value. As you can
4 see there, we go from 0.38 ratio to 0.72. And
5 I'm not sure I know how to account for that
6 difference, but clearly the two sampling data
7 sets were somewhat different. I'm not sure
8 that's the '95 data set which was done on the
9 stratum level. That was done at an earlier
10 time.

11 MEMBER ZIEMER: Hans, what table
12 was that in?

13 DR. BEHLING: This is table four
14 and five.

15 MEMBER ZIEMER: Okay, got you.

16 MR. STIVER: Bottom of page six.

17 DR. BEHLING: Okay, so as I
18 mentioned before, the reference in the NIOSH
19 site profile for Fernald in section 5.2.4, I'm
20 going to read a quotation so that for people
21 who might be on the phone who don't have
22 access to either the hard copy or the computer

1 screen, I will read something that's very
2 important.

3 In the site profile, NIOSH states
4 the following. "As previously stated, the
5 contents of the silos have not been disturbed
6 during the storage to any large degree;
7 however, it's been calculated that during the
8 1953 to 1958 period, 5,000 to 6,000 curies per
9 year of radon were released from the silos."
10 And they reference the 1995 RAC Report.

11 "Considering the expected large
12 difference in release rates due to barometric
13 pressure changes, release rates would average
14 up to 15 to 20 curies per day after the
15 addition of the silos were complete."

16 Anyway, what I wanted to simply
17 emphasize here again is that these values were
18 not NIOSH's values, but they were adopted from
19 the 1995 RAC Report.

20 The model that John Till and his
21 co-authors used was really a complex model.
22 It was based on a diffusion kinetics of radon

1 to waste package to head space ventilation
2 barometric pressure, and a lot of modeling
3 data that had to make numerous assumptions
4 regarding what could have been released.

5 And if you go further down the
6 page, you will see some of his own concerns
7 that he expressed in the report, but I won't
8 for the sake of time deal with those issues.
9 But let me go to page number eight, and near
10 the top of the page, I have a title section
11 from Page J-28 of Appendix J, and that's a
12 reference to the John Till report of 1995, and
13 I'll read that again for the benefit of people
14 who may not have access to the report.

15 In that report, John Till says the
16 following. The silo interior was sampled on
17 November 4, 1987, prior to the operation of
18 the Radon Treatment System -- and parentheses
19 RTS, because I'm going to refer to RTS -- and
20 prior to the application of the exterior
21 formerly to the silo domes. And the RTS is a
22 system that pumps air from the silos through

1 a series of calcium sulfate and charcoal beds,
2 which removes Radon-222, enough potential
3 daughter products of Radon-222, from the air
4 space of the silos and reduces the direct
5 radiation exposure rate on the silo domes.

6 The system is used to reduce radiation
7 exposures to personnel involved on the silos.

8 In other words, you were sending
9 workers up on top of the silos, the exterior
10 of the silos, and the intent of the radiation
11 -- Radon Treatment System is to vent the head
12 space and in the process reduce the dose rate
13 because of the fact that you're removing the
14 radon and its daughters.

15 Furthermore, I'm also going to
16 quote a couple of other statements here.
17 Searches through the historical records of the
18 FMC have located some results of radiation
19 exposure rates on top of the K-65 silo domes
20 which are summarized in Table J-19, and that
21 table I exclude as Exhibit Number One.

22 And let me ask those who have a

1 copy of the report to turn to page 10, which
2 is -- comes directly -- it's a verbatim
3 replication of the table J-19 from the report
4 that John Till issued in '95. And you will
5 see for the sake of, again, simplicity I have
6 identified by hour certain dates.

7 The top of the table involves
8 dates. The first one is April 1964. The
9 second one is '72. There are two of them in
10 March '72, and then there's May '73, and a
11 couple of other ones in May '72 and July '73.

12 Important to note here is the fact
13 that these measurements were taken prior to
14 1979 when there was corrective measures taken
15 to seal the dome that is a gooseneck and the
16 manhole covers, et cetera. And important to
17 note here are the -- is the column that
18 contains the measurements of dose rates in
19 milliR per hour. So you'll see on April 1964,
20 75 millirem per hour, and on March 1972, below
21 that is 30 and so forth and so forth.

22 And on the far right side you will

1 see some statements with regard to the average
2 values which defines those particular
3 measurements. You will see, for instance, in
4 the case of -- let's see, no, they don't on
5 this one.

6 But anyway, those are the dose
7 rate measurements. Some were as low as 30 mR
8 per hour to as high as 90 with an average
9 somewhere in the sixties to seventy milliR per
10 hour. That's an important number to remember.

11 Now on the next -- below that
12 series of columns you'll have dates after the
13 ceiling silo opening, and we'll skip the
14 majority of them until you get down to the
15 bottom where you have two more arrows
16 identifying two particular dates. The first
17 one is from the fourth from the bottom up,
18 November 1987. Again, you have a contact
19 reading, and that contact reading is 168 to
20 208 milliRs per hour, and the average was 193.

21 On that same date they start out -
22 - they start with the Radon Treatment System,

1 which I will go back in a few seconds and
2 explain what the technical specifications are.

3 Oh, let me just simply refer to
4 you to the page eight on the bottom, which
5 explains that the RT system was operated on
6 one silo at a time with a flow rate of a
7 thousand cubic feet per minute and was
8 operated until the radiation level on top of
9 the silo dome surface contact stopped
10 decreasing, and that usually meant several
11 hours.

12 And then it goes on to say the
13 following. "With these flow rate and
14 operating times and an assumed removal
15 efficiency close to 100 percent of the radon
16 concentrations in the silo air space should
17 have reduced to less than three percent of the
18 initial concentration. Thus, for this
19 analysis the exposure rate measurements made
20 after the operation of the RTS are considered
21 to represent the quote background exposure
22 rate in the absence of radon daughters in the

1 silo air."

2 So let's go back to Table --
3 Exhibit 1 on page 10 and look at the contact
4 reading after the RTS was in operation, and
5 you see for November 1987 the contact reading
6 was reduced from an average of 193 to 35.5 to
7 68, with an average of 55 milliR per hour.

8 Another attempt was to measure it
9 below on November 1987 and, again, the
10 baseline reading before the RTS varied between
11 221 to 250 MR per hour, with an average of
12 230. Once you activated the RTS system, that
13 was reduced to 68.

14 Now you look at those particular
15 measurements after the RTS that assumedly
16 cleared in excess of 97 percent of the radon
17 out of the head space, and you will come to
18 the conclusion that pre-1980 when the -- the
19 gooseneck and the other penetrations were
20 still open and actively venting that the dose
21 rates on top of the dome pre-1980 was
22 essentially nearly identical to the dose rates

1 that you would experience after the activation
2 of the RTS system, meaning that you have
3 vented essentially all of the radon and the
4 daughters from the head space.

5 And on that basis I concluded that
6 in essence prior to the serious attempt to
7 finally seal the domes of Silos One and Two,
8 the ventilation rates from those domes through
9 whatever penetration that the goosenecks, the
10 manhole covers essentially was equivalent in
11 efficiency in removing the radon gas as the
12 RTS that has at least as a specification
13 designed to clear the head space volume of air
14 at a thousand cubic feet per minute and was
15 operated until essentially there was no
16 further reduction in the dose rate on top of
17 the dome.

18 Now if you go to Exhibit Two, it
19 basically depicts the numbers that I just
20 talked to you, on page 11 you will see the
21 exposure rate in milliR per hour and a -- you
22 have several data points prior to 1979 -- June

1 of 1979, and you see that the dose rate among
2 those -- those lower on the left hand side
3 oscillates somewhere between 60 to maybe 75
4 millirem per hour, and at that very moment in
5 time when that modification was done to Silos
6 One and Two you see a rapid acceleration in
7 terms of dose rate that the highest reading
8 was close to 400 milliR per hour.

9 Now on that basis, I concluded
10 that obviously the silos must have vented most
11 of the radon that escaped from the waste
12 package from the raffinate waste package into
13 the head space and was vented into the
14 environment.

15 Now the big question that I had to
16 deal with is what do we do as a starting
17 point. Obviously, as a starting point the
18 equilibrium between Radium-226 and Radon-222
19 could have been anything basically as an upper
20 limit and lower limit from zero up to 100
21 percent equilibrium. And for that reason, not
22 knowing the data and not having any

1 information as to what the ratio between those
2 two radionuclides are at time of emplacement,
3 I consulted a couple of documents from the
4 scientific literature which are supplied to
5 you as Appendix -- let me see, as Attachment
6 One. It's an article by Claude W. Sill, and
7 if you had a chance to read it there were
8 measurements taken both of mined ore, uranium
9 ore, as well as mill tailings.

10 And you will see that in both in
11 ore and mill tailings the ratio between -- if
12 you go to page 27 of my report, you will see
13 a column of Radium-226 and Lead-210 as ratios
14 to the parent uranium. They're basically
15 identical. So at least in ore you see the
16 ratio between radium and Lead-210, essentially
17 at unity. They're essentially at equilibrium.

18 Of course, one could say that
19 doesn't count, but let's go to uranium mill
20 tailings, and I think I summarized that
21 actually in the report on page 13. If you
22 looked at the tailings, and they apparently

1 had several different samples to choose from -
2 - one from a single mill, the other one was a
3 composite of 16 mills. In the single mill
4 tailings, the ratio between Lead-210 and the
5 Radium-226 -- there's a typo there, it's 226 -
6 - was 90 percent. For the composite of 16
7 mills the ratio was 87 percent. So I wasn't
8 really quite certain as to what to do about
9 estimating or making assumptions of a starting
10 point, but what I did do was to essentially
11 assume that the disequilibrium that we saw in
12 1991 when there were core samples taken out of
13 Silos One and Two, that level of
14 disequilibrium existed at the time of
15 emplacement, which I consider as relatively
16 unconservative that I might have ended up with
17 a significantly higher ventilation rate than
18 I ended up assuming.

19 And I assume that that
20 disequilibrium that existed at the time of
21 emplacement continued throughout the entire
22 period up to 1979, June of 1979, when the

1 modification took place. And on that basis I
2 came up with my numbers which I can just
3 summarize, but I concluded that somewhere in
4 excess of 100,000 curies per year between
5 Silos One and Two may have been ventilated per
6 year between the time of emplacement and the
7 time of the modifications in June of 1979.

8 So for the sake of brevity I'm not
9 going to continue adding more of the details,
10 but if you have the report you can certainly
11 look at some of the additional information
12 that I've included that would support the
13 notion that the 5,000 curies that were
14 initially estimated by John Till in his 1995
15 RAC Report may have significantly
16 underestimated the release, which I estimate
17 to be in excess of 100,000 for both Silos One
18 and Two.

19 DR. MAURO: I'd like to add one
20 last thing. We did review this -- the
21 February 2000 report by Sam Chu, and basically
22 what Sam argues is that, no, the diffusion

1 calculation, the transport contained error,
2 which is a transport calculation where you
3 know the temperature difference, and you could
4 model diffusion.

5 Argues that that's a very reliable
6 way to predict source terms. It's basically
7 to develop reactors, but the reality is, as
8 Hans pointed out, it's filled with lots of
9 assumptions regarding the diffusion
10 coefficients, crack size, delta T. There's
11 a whole litany of assumptions you have to
12 make.

13 We checked those numbers, that is
14 that were derived originally by RAC, and we
15 got 6,000. In other words so if you were to
16 use the RAC or John Till approach, we would
17 get 6,000, but we think that that's a very
18 indirect way of trying to get a handle on the
19 source term. We think Hans's approach, which
20 is based on the deficit of the progeny
21 compared to the radium, coupled with the fact
22 that there's good evidence that the -- there

1 really, there was no radon and radon progeny
2 inventory in the head space meant that the
3 radon left, and that the real number is
4 probably more like 60,000 curies per year, so
5 we hold to our position.

6 Now I'll be the first to admit
7 this is not an SEC issue. What we believe is
8 that the estimate of the radon release rate
9 and associated doses has been underestimated
10 by a factor of 10, if not more.

11 DR. NETON: Well, I honestly
12 haven't kept up with this issue probably as
13 much as I should, and I'd like to go back and
14 review Hans's report because it's been some
15 time since I looked at it. But I've thought
16 about this a little bit, and I remembered that
17 the Fernald dose reconstruction project was
18 very much in the public eye. In fact, it was
19 so much in the public eye I recall that they
20 commissioned a National Academy of Sciences
21 review of that dose reconstruction.

22 So a committee of the National

1 Academy of Sciences convened, reviewed that
2 dose reconstruction in 1977, and in the
3 opinion of the committee the RAC approach was
4 considered to be -- I forget their exact words
5 -- the committee concludes that the methods
6 used in the Fernald dose reconstruction
7 project are appropriate and scientifically
8 sound. Furthermore, they went on to say, in
9 the opinion of the committee the RAC approach
10 has resulted in an overestimation of doses to
11 people exposed to radon. So here we have
12 somewhat of a difference of opinions.

13 DR. MAURO: Yes, we do.

14 DR. NETON: And we have one
15 expert opinion that has confirmed the RAC
16 approach, the National Academy of Sciences
17 review. I have to say I'd like to go back and
18 look at Hans's analysis. I mean, I respect
19 Hans, and I need to look at his analysis
20 again.

21 DR. BEHLING: And let me just
22 finish off. I really try to avoid models if

1 I can, and to me those particular data points
2 regarding dose rates on top of the dome that's
3 involved pre-1979 measurements and then, of
4 course, the use of the radon treatment system
5 on and before it is activated tell me an awful
6 lot of information that transcends non-
7 empirical model data that, for instance, John
8 Till used.

9 And if, in fact, the radon
10 treatment system that was venting the head
11 space at 1,000 cubic feet per minute was
12 operating for several hours with a ventilation
13 rate of 1.2 ventilation volumes per hour, what
14 does that tell you about the fact that those
15 dose rate measurements in earlier years, pre-
16 '79, were essentially identical to the
17 measurements after the RTS was activated until
18 the dose rate no longer dropped.

19 To me that pretty much tells me
20 more than somebody's opinion about the RAC
21 data, even if it involves such noble people as
22 the National Academy of Science. All they did

1 was look at what we did when we looked at the
2 RAC report, and John just finished telling you
3 we looked at the data and said, hey, you know,
4 if this is all you've got you may have to
5 concur with the conclusion that it was five to
6 six thousand curies per year. But maybe they
7 should look at the Appendix J of the RAC
8 report and then identify the various numbers
9 that I identified and then determine whether
10 or not you still feel that the RAC report has
11 in its original form a more credible data.

12 DR. NETON: There also occurs to
13 me that there was a recent analysis done by
14 the University of Cincinnati, funded by NIOSH,
15 by the way, that went and reconstructed the
16 dose for all -- all workers at Fernald, I
17 think over all -- not all time but through a
18 certain time period, starting I think at the
19 beginning of the entombment of the K-65
20 material. And my recollection was that they
21 developed yet another diffusion model. I'm
22 not sure how much it relied as a starting

1 point on the RAC data, but I'd like to go back
2 and look at that, as well.

3 So there's some issues on the
4 table here. I have some concerns about the --
5 the diffusion -- how deep a pile of material
6 this way and Hans's assumption about emanation
7 rates and uniformity of that, and all kinds of
8 concerns like that that I think need to be
9 really looked at in some detail.

10 I respect Hans. He's an excellent
11 scientist, but I think so far it's not passing
12 the peer review process, and I'll go back and
13 look at it myself.

14 MEMBER ZIEMER: Hans, this is
15 Ziemer. I have a question, too, maybe you can
16 help me clarify. In going through your
17 calculations around page 15 and so on where
18 you started with the inventory of radium, did
19 that come from the total inventory in the
20 silos?

21 DR. BEHLING: Yes, it came
22 basically from the curie content of Radium-

1 226.

2 MEMBER ZIEMER: Okay, so that's
3 what I thought you had done, so it appears
4 that you're assuming that all of the radium or
5 all of the radon atoms generated by the decay
6 of radium actually are vented?

7 DR. BEHLING: Well, not quite.
8 As I said there is obviously the ratio of
9 about 38 to 40 percent that remain. I'm not
10 saying no. I did not say 100 percent, but the
11 fact that in 1991, which is approximately 40
12 years after the emplacement of the raffinate
13 waste you still only have a 40 percent ratio
14 between Lead-210 and Radium-226.

15 Now Lead-210 has a half-life of 21
16 years and in essence if -- let's assume for a
17 moment that the -- all of the radon remains in
18 the waste package and decayed and gave rise to
19 a starting point that had zero Lead-210.
20 After 40 years, in 1991 we're talking about 40
21 years, you would have had two half-lives of in
22 growth, meaning you would have had at least 75

1 percent.

2 And so you realize that radon has
3 to have escaped. There's no question around
4 that, and the question now is if it escaped
5 the waste package and ended up in the head
6 space, what happened to it? And this is where
7 I believe the second issue comes into play
8 with regard to the data that was reported in
9 Appendix J.

10 It's clear that the radon left the
11 waste package or the matrix of the raffinate
12 waste. If it enters the head space, what
13 happened to it? And if the dose rates pre-
14 1979 and post-'79 with the RTS system are
15 essentially identical, you almost have little
16 or no choice but to conclude that that radon
17 had to have escaped.

18 MR. MORRIS: So essentially
19 you're saying that 97 percent of the radon
20 entering the head space was released to the
21 environment?

22 DR. BEHLING: Well, those are the

1 two data points that I rely on, and I believe
2 that's the conclusion that you almost have to
3 come to. My discussion about the Venturi
4 effect does not to explain these numbers. It
5 just explains the possibility by which an
6 enhanced release rates could have occurred.
7 When you have a dome that is basically an
8 airplane or an asymmetrical foil, it's subject
9 to the Venturi effect and may have created a
10 significant vacuum in the head space that
11 basically was the means by which it escaped,
12 even through modest penetrations.

13 MR. MORRIS: Excuse me, Brad?
14 Are you interested now in getting this summary
15 of what Sam Chu reported in his paper in
16 rebuttal or is that -- I don't know what you
17 want to do.

18 CHAIRMAN CLAWSON: If you're
19 good, Jim also said he'd been a while and he'd
20 like to --

21 DR. NETON: I'd like to -- I
22 mean, John characterized it as essentially

1 saying that it's definitely -- he bought off
2 on the RAC assumption. I think that's what
3 John characterized the Sam Chu report.

4 DR. MAURO: Oh, no. I said that
5 if we run the model -- no, no, no. We don't
6 accept -- we don't believe this is the way to
7 do it. We think --

8 DR. NETON: No, but what I'm
9 saying is Sam Chu evaluated Hans's approach --

10 DR. MAURO: Yes.

11 DR. NETON: -- and if you have
12 anything of substance to offer in rebuttal to
13 Hans's arguments.

14 DR. MAURO: All he said was that
15 the diffusion model --

16 MR. MORRIS: Well, you know, why
17 don't you let me represent that instead of you
18 representing that?

19 DR. MAURO: Go ahead.

20 MR. MORRIS: Basically, Sam said,
21 okay, we'll start with the beginning
22 assumption of the amount of radon that reached

1 the head space that Hans took, but that's not
2 the end of the story. There are barriers to
3 the radon getting out of that head space and
4 into the environment.

5 And if you think about it even for
6 a moment you'll think oh, yes, there are
7 barriers. There is the matrix of the waste,
8 and then there is the dome. I mean, that's
9 why there is a dose rate there on the top
10 because it actually impedes the flow of the
11 radon.

12 So Sam went through -- let me see
13 if I can get to my highlighted sections here.
14 So missing from that assessment that Hans just
15 described is the amount of radon released to
16 the environment from the head space -- has to
17 consider that containment capability of the
18 silo, the retention time of the radon in the
19 head space, and the depletion of the radon in
20 the head space due to radioactive decay.

21 The assessment really doesn't take
22 into affect -- into account the amount of

1 radon released to the environment that was
2 driven by the daily temperature differentials,
3 the Venturi effect of prevailing wind speeds,
4 the retention time of radon, and the
5 depletion. Fundamentally, radon is heavier
6 than air and consequently will tend to be in
7 the bottom of the head space just by nature
8 unless it is stirred up with some mechanical
9 force that's moving it up. There were
10 openings in the top of the dome and cracks
11 also. There was a six-inch gooseneck pipe
12 bend, the gaps between the manholes and the
13 manhole covers, and so collectively you can
14 begin to describe these as leak paths.

15 A leak path factor is the ratio of
16 what's released to what's contained, and there
17 is a computer code that the NRC uses called
18 CONTAIN. CONTAIN 2.0 is the version that's
19 out now. It's a generalized mass transport
20 and thermal-hydraulics computer code, and it
21 was developed to predict the thermal-hydraulic
22 response inside a nuclear reactor, but it's

1 sufficiently versatile to take any set of
2 pressure or temperature-driven flows and the
3 cells which would be the components of the
4 waste, sort of the layer cake waste, and then
5 the head space is a cell, and then the release
6 portion and actually do a predicted model that
7 -- that can define, based on these mechanical
8 and physical properties that can be measured
9 or assumed easily, the amount of flow that
10 could happen.

11 And so, you know, Sam goes ahead
12 to show the equations and then implements the
13 -- the calculation with the contained code.
14 The bottom line is that the numbers really do
15 not change very much from where we left it in
16 the Technical Basis Document, so we're content
17 with saying that we can validate by this
18 modeling and the assumptions that Hans begins
19 with -- provides us to begin with a rationale
20 for having exactly the same position that we
21 left in the Technical Basis Document.

22 MEMBER ZIEMER: So you end up in

1 your analysis with something which you might
2 call a resident time of the radon in the head
3 space?

4 MR. MORRIS: Yes.

5 MEMBER ZIEMER: Which is roughly
6 what? Do you know what that --

7 MR. MORRIS: I can find it if you
8 want --

9 MEMBER ZIEMER: It looks like
10 it's got to be a couple days.

11 MR. MORRIS: Well, I think it's
12 more than that. If you would let me look that
13 number up. That's not the kind of detail I
14 have at --

15 MEMBER ZIEMER: No, no. I
16 understand, but I'm just trying to get a feel
17 because Hans's number like -- well, roughly a
18 100,000 versus -- here, 30,000, is it a factor
19 of two or three?

20 MR. ROLFES: Our current
21 Technical Basis Document has 6,000 curies per
22 year, and the white paper that we produced

1 actually has 660 curies being vented, so this
2 model, the CONTAIN calculations that we
3 presented in the white paper here have
4 essentially another order of magnitude lower
5 than what we have in our current approved
6 Technical Basis Document.

7 MEMBER ZIEMER: Okay. So you
8 need several effective half lives if you want
9 to think of it that way.

10 MR. ROLFES: And basically these
11 are -- these are orifice-driven flows.

12 MEMBER ZIEMER: Yes, I
13 understand.

14 MR. ROLFES: And so, you know,
15 you just can't instantly have everything come
16 out.

17 MEMBER ZIEMER: No, no.

18 DR. BEHLING: I guess I have a
19 question as to why you would explain or how
20 you can explain the quantum leap in the
21 reduction in dose rates following the RTS that
22 reduces the dose rate on top of the dome to

1 levels that essentially are pre-'79, and you
2 can reasonably assume that that is the result
3 of having vented after several hours, and most
4 of the radon daughters are short-lived radon
5 daughters with half-lives of microseconds to
6 up to twenty-some minutes. And if you run the
7 RTS for a period of three hours you basically
8 blast out all of the radon and the short-lived
9 radon daughters which result in a massive
10 reduction in the dose rate, and as far as I'm
11 concerned the post-1987 RTS values are
12 essentially similar to the pre-1979
13 modifications to the dome. And to me those
14 numbers speak everything I need to know.

15 DR. NETON: I'm confused, Hans.
16 You're saying that by virtue of the fact that
17 they can pump the short-lived progeny out of
18 the dome and reduce the dose rates, that plays
19 into your hand?

20 DR. BEHLING: Well, yes. I
21 believe if you can essentially pump and keep
22 the radon system on indefinitely, meaning that

1 there is no build-up of radon in the head
2 space and you end up with a dose rate that is
3 the same as the dose rate before the RTS
4 before the dome was modified --

5 DR. NETON: I could suggest that,
6 you know, the emanation rate coming out of the
7 material is pretty low, and once you pump it
8 out of the head space you've removed the
9 source term.

10 DR. BEHLING: The same thing with
11 -- if you have natural ventilation --

12 DR. MAURO: You wouldn't have a
13 deficit. You can't have it both ways.

14 DR. NETON: I suspect that
15 there's a lot of plate-out of this material on
16 the dome itself. Radon has a very large
17 affinity for -- it's born charged. Radon
18 progeny are born ionized to some degree.
19 There's a charge on those particles, and, in
20 fact, in an indoor environment the equilibrium
21 ratio is only around, what, 30 percent because
22 they attach to the surfaces of the material in

1 the area that they're born.

2 DR. MAURO: If the radon stayed
3 in the dome pre-1979, why is the dose rate 30
4 to 60 millirem per hour? That means that it's
5 not there. The dose rate on the top of the
6 dome before 1979 is low. It means that you
7 don't have this inventory sitting up there
8 inside this dome space. The radon isn't
9 there. And the fact that after they sealed it
10 -- in fact, if what you're saying is true you
11 would have expected to see 200, 250 MR per
12 hour pre-1979 because it would be trapped in
13 there, giving you this high dose rate, and you
14 don't see that.

15 DR. NETON: Well, didn't they
16 also put a cap on top of the silo material
17 itself? There was a massive cover -- a
18 bentonite clay cap on top of the silo to
19 prevent the migration --

20 MEMBER ZIEMER: That was later.

21 DR. NETON: That was in the
22 1980s.

1 DR. MAURO: We have to talk to --

2 DR. NETON: There were several
3 campaigns to put a cap on the inner material
4 to prevent exactly what Hans is talking about,
5 the migration of material out of the -- out of
6 the silos.

7 DR. MAURO: Look at the '87. I
8 mean, the numbers are -- I mean, it's
9 screaming at you. When you turn on that vent,
10 you drop right back down. After you turn on
11 the vent you enter the head space of radon
12 using the vent system, you're right back down
13 to the 35 MR per hour, which is what you have
14 before 1979.

15 DR. NETON: And how long did it
16 take to build back up?

17 DR. MAURO: The next reading, it
18 doesn't take long.

19 DR. BEHLING: Well, you can look
20 at that if you look at, again --

21 DR. MAURO: The graph will tell
22 you.

1 DR. NETON: Okay, we're probably
2 not going to solve it here.

3 DR. MAURO: I know, but I mean --
4 listen, I mean, I look at this and I say the
5 common sense argument -- this is really what
6 we have here is Hans brought to the table a
7 common sense argument that really directly
8 contradicts the sophisticated transport
9 equation calculation. The two are
10 incompatible. The numbers we're looking at in
11 Exhibit One and the model -- something's
12 wrong, and quite frankly I had much sooner
13 trust the empirical data than I would these
14 transfer models.

15 MR. MORRIS: But in terms of
16 common sense, it doesn't make common sense to
17 assume that the silo did nothing to impede the
18 flow of radon.

19 DR. MAURO: Why would you say
20 that?

21 MR. MORRIS: It makes no common
22 sense to assume that none of these hold-up

1 factors were in play.

2 DR. BEHLING: Well, let me shed
3 some light on the issue that simulates the
4 dome to a floor in a basement under which you
5 may accumulate radon. You can -- and I've
6 done this before because my house suffered.
7 I lived in the radon prone area. If you use
8 a toxic paint and you seal all but the most
9 smallest of cracks, you have done nothing.
10 The infiltration remains the same. It isn't
11 until you introduce a ventilation, a sub-slab
12 ventilation that you actually then do
13 something constructive. So it doesn't take
14 much of a perforation to vent most of the
15 material if you have a negative pressure
16 inside your basement compared to the pressure
17 underneath your slab.

18 So I do believe that you don't
19 need to have huge, huge gaps of cracks. A few
20 major cracks, a gooseneck, and a few other
21 things under the condition of a Venturi effect
22 can essentially serve to vent the head space

1 fairly efficiently to the level where you see
2 dose rates that pre-1979 are equivalent to the
3 ventilation rates and the reduction in dose
4 rates with the RTS system.

5 DR. NETON: Well, again, we need
6 to take a look at this, but I agree with John
7 that this is not necessarily an SEC issue.
8 It's a novel analysis of an issue that has
9 been reviewed by the National Academy of
10 Sciences, which I tend to trust, but we need
11 to look at it in light of this new concept.

12 DR. MAURO: You know what?
13 That's our story. I really would like John to
14 get a chance to -- give John a break, but I
15 know we're in the home stretch, but you made
16 a trip all the way, so to give us a quick --

17 MR. STIVER: Okay, let's go
18 ahead. I'll try to keep it as brief as
19 possible.

20 MEMBER GRIFFON: Before we --

21 MEMBER ZIEMER: NIOSH is going to
22 review this.

1 DR. NETON: Well, we already have
2 a review. We'd appreciate SC&A to respond to
3 it.

4 DR. MAURO: No, no, no. Our
5 response is very straightforward. We don't
6 believe running -- is that contained air or
7 contained --

8 DR. NETON: Contained.

9 DR. MAURO: -- a transport code
10 that makes certain assumptions -- diffusion
11 coefficients, average your differences is the
12 way to come at this problem when you've got
13 data like this. You know, what are you going
14 to trust, and really this becomes a matter of
15 scientific judgment. Do you trust -- you
16 know, the barriers that you're talking about
17 it, it's very difficult to contain radon.

18 MEMBER ZIEMER: Let me ask a
19 question regardless of which number's right.
20 How are you using -- remind me of how you're
21 using the radon information that's vented from
22 the silos.

1 MR. ROLFES: Basically, we -- the
2 way we would reconstruct an individual's radon
3 intakes, we're assigning default values based
4 on the site profile.

5 MEMBER ZIEMER: Down wind or are
6 they location specific?

7 MR. MORRIS: They're location
8 specific. In the environmental.

9 MEMBER GRIFFON: In the
10 environmental, and then, I mean, that's what
11 I want to get back to. This part, I think, I
12 actually agree with this that this side of it
13 is a site profile deal. The question that I'm
14 not sure is -- might remain an SEC question is
15 how is dose assigned, you know?

16 MR. ROLFES: Exactly. I guess
17 exactly how this affects claims, you know, we
18 can take a look at some of the perimeter radon
19 air monitoring data and other track-etch
20 detector data that we have.

21 MEMBER ZIEMER: Are you seeing
22 significant lung doses to people in the

1 environment from the radon?

2 MR. ROLFES: Yes, but the K-65
3 silos aren't necessarily the sole source.
4 It's more people working with Q-11 in process.

5 MEMBER ZIEMER: I'm really asking
6 you what is this contributing to the big
7 picture, or is it too early to say?

8 DR. NETON: It's pretty small
9 compared --

10 MEMBER ZIEMER: That's what I was
11 --

12 DR. NETON: I mean, we've -- 90
13 plus percent of the lung cancers in --
14 respiratory track program are compensated. So
15 there's a large dosage associated with a
16 missed dose associated with uranium intakes,
17 thorium intakes, thoron in the building, radon
18 in the building. It's sort of an
19 environmental issue where how much radon could
20 be wafting outside from the K-65 silos is an
21 environmental TBD issue that we would use to
22 assign to people who were not necessarily

1 production-type workers.

2 MEMBER GRIFFON: But that's the
3 question here, and I'm going back to the
4 matrix, believe it or not, at a quarter of
5 five. I mean, I was, while Hans was
6 presenting there, I was flagging some old --
7 going through and looking at the old actions
8 that we might have forgotten about, but for
9 4.2-1 this is that question that, Mark, I
10 think you just alluded to is NIOSH is supposed
11 to further evaluate the ability to reconstruct
12 doses from raffinate specifically for workers
13 exposed to materials from Silo Three. And
14 then updating -- there's another one, NIOSH is
15 updating Technical Basis Document to consider
16 the Pinney radon study. That gets into the Q-
17 11 stuff, I think. So this is back to the
18 question of not only the K-65 but the Q-11
19 silo stuff and how are you assigning radon to
20 a site.

21 DR. NETON: That's correct.
22 That's a separate issue, but Hans's analysis

1 would -- that's actually contradicted in the
2 RAC study, the Pinney Study, and other studies
3 that we've been using.

4 MEMBER GRIFFON: No, I understand
5 that, but this part of it, this dose
6 assignment part of it to me is not necessarily
7 just a site profile issue. I mean, how are
8 you going to determine who was in what areas
9 and how are you going to decide who gets what
10 doses. That's that age-old question.

11 DR. NETON: I need to talk with
12 our group here.

13 MEMBER GRIFFON: I'm just keeping
14 that action on the table.

15 DR. NETON: Remember, though,
16 that there is a Pinney study out there that
17 has reconstructed a dose for all workers based
18 on some default values --

19 MEMBER GRIFFON: I'm very
20 familiar with it. I just don't want to lose
21 the action. That's all I'm saying is that --
22 it sounds like we're closing it out kind of as

1 a site profile issue, and I'm saying for that
2 side of it, I don't disagree.

3 DR. NETON: I think that the SC&A
4 analysis that Hans has done is not a site
5 profile issue.

6 MEMBER GRIFFON: It is a site
7 profile issue, right. I agree with that, but
8 the other side --

9 DR. NETON: Exactly.

10 MEMBER GRIFFON: That's why I
11 want to keep it on the table. That's all.
12 Okay, I'm just reminding us that it's out
13 there, and I'm going to update this matrix
14 when we leave this meeting.

15 And I'm going to do like I've done
16 in the dose reconstruction subcommittee. I'm
17 going to highlight the actions in yellow. It
18 seems to work very well on these kinds of
19 documents so the actions -- you can just flip
20 through on the screen and find where we left
21 off because there's several of them that we
22 haven't discussed, and they're kind of getting

1 lost in the weeds a little bit. And I want to
2 make sure that we close them out because, you
3 know, the petitioner's watching us and, you
4 know, we have to be responsive to them.

5 CHAIRMAN CLAWSON: We're going to
6 lower -- before you take off real quick, we're
7 going to lower our intellectual level way down
8 here. I'm trying to understand something
9 here, and I apologize for my ignorance.

10 But pre-1979 we were really
11 maintaining a 50MR off the top of the silos,
12 and after they sealed it all of a sudden we're
13 going to 250 to -- to as high as what I see as
14 400.

15 And, Hans, correct me if I'm
16 wrong. What -- what you're saying is -- is
17 this is showing what could have been possibly
18 venting out of the K-65 silo previous before
19 sealing it?

20 MEMBER ZIEMER: Right.

21 DR. BEHLING: Yes, the truth --

22 CHAIRMAN CLAWSON: How much

1 activity is going on, so really what we're
2 doing is when we're pumping all that head
3 space down we're basically seeing the
4 radiation that's being given off by the -- the
5 actual product that's inside?

6 DR. BEHLING: Well, yes, you
7 obviously have radon activity in the
8 raffinates, and that is your -- as was stated
9 -- let me see here -- in one of the things
10 that I quoted.

11 On page -- top of nine the
12 statement -- and this comes from, again, the
13 RAC report: "Thus, for this analysis the
14 exposure rate measurements made after
15 operation of the RTS are considered to
16 represent the background exposure rate in the
17 absence of radon daughters in the silo air."

18 What basically, I was saying,
19 we're looking at is this. If, for instance,
20 you had a -- the RTS system operating for an
21 indefinite period of time, not just for a few
22 hours so that workers could go up, but based

1 on the fact that as the statement says they
2 would run the RTS until there was no further
3 reduction in the dose rate.

4 What you would then essentially
5 assure yourself of is that there was no
6 additional build up of radon in the head
7 space, and if at that point you had a dose
8 rate measurement of 65 or 70 milliR per hour
9 and then realized that pre-1979 you had no RTS
10 but it was a continuous ventilation system and
11 the dose rate never went much above the 65 to
12 70 MR per hour.

13 So you, in essence, have to come
14 to the realization that pre-'79 the
15 ventilation rate was basically in a de facto
16 RTS system.

17 CHAIRMAN CLAWSON: Okay, I just
18 wanted to make sure that I understood what you
19 were saying. I appreciate that, so basically
20 the action item that we're going to have is
21 that NIOSH is going to --

22 DR. NETON: We've looked at it.

1 It's been determined that this particular
2 issue rated by SC&A is a site profile issue,
3 so in light of the fact that this SEC
4 evaluation's been in process for over two
5 years now, I think we've put that on the back
6 burner at this point.

7 I mean, contrary to what I said
8 I'd still like to intellectually look at it
9 and we'll get to it, but we've got a lot of
10 other more pressing issues to resolve from the
11 SEC perspective at this point than to burden
12 to SEC review process with this.

13 CHAIRMAN CLAWSON: And I
14 understand that, but like we said on the
15 matrix here it does actually get back to the
16 radon --

17 DR. NETON: There is a radon
18 reconstruction issue that is related but not
19 directly related to Hans's. If Hans is
20 correct and SC&A is correct, it would be a
21 scaling factor that could be applied to all
22 the radon doses that we assign on the site.

1 The question is can we actually
2 figure out who to assign radon to, and if we
3 use six curies or 60 curies, it doesn't
4 matter. It's a scaling factor.

5 DR. MAURO: The issue remains --

6 DR. NETON: The issue remains,
7 but it's not -- it doesn't mean that we can't
8 bound them to some degree of certainty.

9 CHAIRMAN CLAWSON: Okay --

10 MR. ROLFES: Once again, the
11 organ of significant -- you know, the target
12 organ essentially is the respiratory tract,
13 and I think we, you know, reiterated once
14 again that, you know, 90 percent or greater of
15 the respiratory tract cancers that we've
16 received claims for at Fernald have been
17 compensated.

18 CHAIRMAN CLAWSON: Okay, I
19 appreciate your time to be able to explain
20 that. I'll turn the time back over to you.
21 I'm sorry.

22 MR. STIVER: Okay, let me go

1 ahead and distribute out some of these
2 handouts here.

3 I'm not able to explain the
4 thorium time line that we put together, but we
5 have something taken from Bob Morris' time
6 line that we put together in 2008, which is
7 essentially the exact same information.

8 So I apologize for the poor
9 quality of the first two. We tried to explain
10 what's going on as much as possible.

11 Anyway, I'll try to keep this as
12 brief as possible without losing too much of
13 the detail that I'd like to cover. If you
14 take a look at that first table there that I
15 gave you. That came out of the original
16 version of Bob Morris' white paper on how to
17 use the daily weighted exposure data derived
18 from a alpha-air concentration samples that
19 were taken before the institution of the lung
20 counting program in 1968.

21 That's really the heart of the
22 issue here is can we -- is there sufficient

1 data available to reconstruct thorium doses --
2 internal doses during the period 1954 to 1968
3 before the lung counting program started.

4 My readings have shown there is an
5 extensive discussion of this a little over a
6 year ago in the March 2008 working group
7 meeting. There were action items prepared for
8 October, and for a number of reasons it never
9 got to the table, and so here we are over a
10 year later just getting back to this issue,
11 and as a result I would like to recap some of
12 the action items and some of the discussion
13 that took place back in March about delivering
14 the point.

15 First of all, NIOSH emerged from
16 that meeting with two action items. Both
17 involved posting excessive data to the O
18 drive. The first was to post spreadsheets
19 that contained the DWE data and the latest
20 version of the white paper describing how it
21 could be used in a dose reconstruction for
22 various -- selective years.

1 As a corollary to that the
2 advisory board, recognizing what an enormous
3 undertaking this was, decided that it would be
4 better to do a sampling of that data.
5 Basically, what they decided on was to look at
6 all plants for 1955 through 1966 and then
7 Plant One for 1960, with the supposition that
8 if the data were adequate for those years and
9 those plants then they would probably be
10 adequate for the other years, as well.

11 The second item that NIOSH got was
12 to post these 160 -- roughly 160 DWE reports
13 that you see on that first table. All those
14 little dots -- actually, there's 167 of them.
15 Each one of those represents a facility and
16 year for which these DWE reports are
17 available.

18 Our review of the data that's out
19 there on the O: drive indicate that we were
20 able to discover 152 of these DWE reports.
21 Selective sampling within that set of data
22 indicated that the job exposure evaluation are

1 data that were in those reports were indeed
2 what was transcribed in the spreadsheets.

3 The spreadsheets, and there are
4 two of them, they contain a substantial amount
5 of data. All this job exposure evaluation are
6 data for various clients for different years,
7 but not all of them.

8 And our action item was really to
9 review the data and in addition to that the
10 co-worker model, with the ultimate goal of
11 determining whether this data was adequate for
12 the purposes of dose reconstruction for all
13 categories of personnel, all years, during the
14 periods of exposure.

15 Now one of the first things we
16 came up against was that in looking at the
17 spreadsheet data, all plants are not covered
18 for 1955 and 1966, and in addition to that
19 we're not able to locate a set of data for
20 Plant 96 in 1960, so what we decided to do was
21 to shift the focus to looking at all the
22 different facilities in years of thorium

1 production, or when we believe thorium
2 production took place or inferred that it took
3 place and get an idea of what's really out
4 there, kind of a preliminary snapshot of the
5 data availability as it stands as of March of
6 2009.

7 Now it's important to note that
8 resolving these action items really get to the
9 heart of -- the action items or the issues
10 that were identified basically 4.3-1 through
11 4.3-10. All of those issues are really -- the
12 common thread here is whether this air
13 sampling data is adequate for dose
14 reconstruction, with the exception of 4.3-6
15 which gets to post-production era and whether
16 the lung-counting model is adequate.

17 But most of these other issues all
18 relate to this particular set of data.

19 Now the status of the action item
20 -- before we really get into that there's a
21 couple of concepts and reports and things that
22 I'd like to talk about. This whole idea of

1 what a DWE is, and really what this is, a DWE
2 is just an average daily weight of exposure.
3 It's a way of assessing the exposure potential
4 for a particular job category at a particular
5 facility. And the data that were recorded
6 were in terms of alpha air concentration.
7 These were both in terms of general air and in
8 breathing zone, types of samples.

9 A whole series of anywhere from
10 maybe one to up to 20 to 30 samples would be
11 taken for each subtask that is defined within
12 a particular job category. So you may have 16
13 different tasks for a particular job, and each
14 of those tasks is assigned a time period
15 within that day, so when we sum up all those
16 times you end up with eight, eight and a half
17 hours, basically the entire daily exposure.

18 For those samples that were taken
19 for those different tasks, like I say they can
20 range anywhere from this one sample up to 20
21 to 30. Some very basic statistics were
22 provided just below the high and the average

1 value. And to calculate this DWE then what
2 they did was multiply the time for the task,
3 time for the average concentration, sum all
4 those up, and divide by the total amount of
5 time. And so what you then have is this kind
6 of a generalized overall weighted average of
7 the exposure potential for that person or for
8 that particular job category.

9 And another interesting point is
10 that in looking through just preliminary
11 review, not an in-depth review but just
12 looking at the sample of these DWE reports, it
13 looks like the breathing zone data were really
14 associated with those particular activities
15 that had a high exposure potential over a
16 short period of time, like going into a
17 furnace, breaking open a mold, pouring thorium
18 into one of these bomb retorts along with the
19 calcium and zinc chloride to create the
20 derivatives, anything where you can really be
21 disturbing a lot of material, picking up a lot
22 of dust.

1 The general air samples by
2 contrast were typically in the low
3 concentration areas like cafeteria, hallways,
4 locker rooms, general levels of a particular
5 facility, and so there's a mixture of these,
6 and for each of these DWE calculations. And
7 it's not a situation where you have a general
8 area and breathing zone for the same
9 particular operation or the same particular
10 task. So there really are two different types
11 of measurements.

12 The DWE typically was expressed in
13 multiples of the MAC, maximum air
14 concentration, which was 70 off the EPN per
15 cubic meter for 463 and was changed to 100
16 thereafter. An important point to note here
17 is something that really permeates this entire
18 analysis is that the method, the analytical
19 method employed here is gross health
20 accounting. And gross health accounting
21 doesn't give you any information whatsoever
22 about isotopic specificity. And so what we're

1 forced to do then is rely on process knowledge
2 to infer what particular operations were
3 going. We have uranium going on this year.
4 We have thorium going on, and if we did have
5 thorium for however long is a particular
6 campaign. Was it three weeks, six months,
7 nine months, the entire year?

8 So at this point we're limited in
9 our granularity to basically by years which
10 is in turn inferred from operational knowledge
11 of what was going on.

12 MR. MORRIS: John --

13 MR. STIVER: Yes.

14 MR. MORRIS: -- if I may. When
15 we don't know that data was specific to
16 thorium or uranium we assume that they were
17 thorium for that year.

18 MR. STIVER: Yes, I was going to
19 get to that.

20 And, yes, DWE reports are very
21 interesting. I've had a chance to go through
22 some of these. One that Bob included in his

1 2009 white paper happens to be for Building
2 Nine -- for Plant Nine during 1955, which is
3 the period of high thorium metal production.
4 And these reports are really very striking in
5 that the amount of material that's contained,
6 the consistency from year to year for the
7 different activities, they typically involved
8 about eight sections. They're about 30 to 70
9 pages long. They start out with an
10 introduction, which is just kind of a brief
11 summary of the processes that were going on at
12 the facility, a description of the sampling,
13 and an analysis method that was included.

14 There were two data tables. A
15 summary of Table One provides the average DWE
16 for each job description at the facility and
17 also a DWE for the entire facility.

18 Data Table Two contains the
19 average air concentrations for specific
20 operations or areas.

21 The discussions were very
22 interesting too, because it really provides a

1 more detailed description of the processes or
2 controls that were in place.

3 And then finally there's a
4 recommendation section based on the study or
5 what did they discover, what types of
6 recommendations did they make in terms of
7 controlling exposures, or what types of
8 remediation or mitigation could be employed to
9 reduce the concentrations to workers.

10 And finally we have the appendix,
11 and the appendix is where all these job
12 exposure evaluation reports are found, and
13 this is what really summarizes, you know, the
14 tasks for each of these different
15 descriptions. It gives you line by line what
16 the inputs were for that DWE as I described
17 earlier, and then the initial DWEs.

18 Two of these that I found
19 particularly interesting was the 1954 DWE
20 report for Plant Nine, and that particular
21 report was taken during a pilot study to
22 really try to perfect the chemical processing

1 techniques. There were very few people
2 employed at that time, in the first half of
3 '54.

4 This particular report pertains to
5 19 individuals, and the personnel are named.
6 Their actual names are there, their job
7 descriptions. These job exposure evaluation
8 cards for each of the different 19 personnel -
9 - their positions are included, a description
10 of what was going on at the time. This was
11 just kind of a pilot study, and it's very
12 interesting. And then you see, of course, in
13 the second half of '54 they really start to
14 ramp up their production, and we don't have a
15 DWE that has been identified for that
16 particular period of time.

17 However, for 1955 there's a report
18 that has sampling data collected all the way
19 from March through November of '55, all
20 related to thorium production. In this case,
21 there was 119 personnel, and the description
22 is very enlightening too because there's

1 always been this issue of, well, what
2 particular activities in Plant Nine in
3 relation to other plants. You know, with
4 uranium you have this concerted effort among
5 all the different facilities. You know, you
6 have the sampling plant grinding all the
7 material down to a uniform size. Then you
8 have the refinery producing the nitrate which
9 then goes into an oscillating oxide calcite
10 process, then to a fluoride production, and
11 then finally into metal production.

12 And so there's always been this
13 issue of what was going on at what particular
14 plant and when. Well, this particular report
15 shows that in Plant Nine they received the
16 nitrate. They did the oxide production there,
17 in Plant Nine, they sent it over to Plant Four
18 to be converted into the tetrafluoride. It
19 was then brought back to Plant Nine, and then
20 the derbies were produced in the furnace --
21 that was zinc there -- and then they were sent
22 off for rolling off site and then brought back

1 on site again for cutting into various shapes
2 by the machine.

3 And so this is all contained in
4 that particular DWE report, and this is
5 information I feel would be very useful, and
6 if that similar type of information is in the
7 other reports I think we can have a very good
8 handle on what activities were going on and
9 when, what the exposure limits were, what the
10 job descriptions. All this is a wealth of
11 information that's contained in these and
12 really, I think, help us to reconstruct these
13 doses to a very, very precise level.

14 DR. MAURO: Do you know if that
15 was thorium or uranium?

16 MR. STIVER: It was thorium.
17 That was during -- thorium was going on --
18 1955 was the big year of production.

19 We don't have a DWE report for
20 '56; however, we do have one for '57 and it
21 clearly states that uranium is being produced
22 in '57. So there's a tailing off of thorium

1 in '56 and ramping up of uranium production in
2 1955.

3 This was just kind of a snapshot.
4 There's lots of data we can see here.

5 The next I'd like to do is take a
6 look at the -- which is this multi-colored
7 spreadsheet table here, Table Two. And our
8 initial approach here is to take a look at --
9 based on NIOSH's action item one, we're going
10 to look at just those that were called out
11 there, but it became pretty clear that wasn't
12 going to wake you up.

13 And so this really looks like a
14 really complicated table, but really there's
15 -- there's only four types of data here, okay,
16 and these all relate to the availability of
17 the DWE reports. I've color coded it to try
18 to make it a little bit easier to understand,
19 but the values here -- we have in the first
20 column years of production, and across the top
21 the various columns we have the different
22 plants. Basically, this was similar in

1 structure to Table One from the white paper,
2 and the values that are high, they're bolded
3 and not colored are essentially -- these are
4 values that have been transcribed into the
5 spreadsheets. These are the job exposure
6 evaluation line items. These are not
7 individual samples. These are either averages
8 or because they are single sample it could be
9 averages. But those are the individual task
10 items. That's how many were -- in terms of
11 breathing zone and general area samples.

12 DR. MAURO: Just a quick
13 question, for Plant One, 1954, there's a
14 number 16. Is that a three, I'm sorry, 1953.

15 MR. STIVER: Yes, sixteen
16 breathing zone line item samples.

17 DR. MAURO: Is that 16 breathing
18 zone samples?

19 MR. STIVER: Sixteen averages.

20 DR. MAURO: Averages, so the
21 multiple breathing zone --

22 MR. STIVER: This is basically 16

1 tasks that are identified.

2 DR. MAURO: Sixteen tasks, okay.

3 MEMBER GRIFFON: And those are
4 the average for each task?

5 MR. STIVER: That could contain
6 any -- say for Plant Nine, that DWE report,
7 there was over 400 individual samples for that
8 particular DWE. It could be more, it could be
9 less.

10 MEMBER ZIEMER: And then the 11
11 general areas are specific -- averages of
12 specific areas?

13 MR. STIVER: Those would be just,
14 you know, continuous air monitor --

15 MEMBER ZIEMER: Yes, so 11
16 locations?

17 MR. STIVER: Yes, those would be
18 locations associated with those activities
19 during the period like, say, going to the
20 cafeteria or time spent in the locker room,
21 and so forth.

22 I see Plant One really has the

1 lion's share of the available data at this
2 point. If you get down here below the actual
3 -- below 1969 you see there is the sum of the
4 DWE samples by type. That is just a summation
5 by plant of all the years.

6 And the next level below that
7 shows the ratio, basically the breathing zone
8 to general air by building, and it's kind of
9 interesting here that you see -- whenever you
10 have -- for the facilities that have more than
11 about 100 samples, the breathing zone portion
12 or proportion ranges from about five to 25
13 percent of the --

14 So what, what does that mean? It
15 may just be that, you know, fewer breathing
16 zone samples are really necessary in order to
17 characterize that. It doesn't mean, like I
18 said before, that these are two different
19 types of measurement, one being more accurate
20 than the other in the same type of activity.
21 They're different activities.

22 And let's see. The light brown

1 here is -- these represent DWE reports that
2 have not yet been transcribed, and there are
3 still quite a few of those. We'll get into
4 exactly how many and what they mean here in a
5 minute.

6 The dark blue shading are reports
7 that we didn't think were available but
8 actually were transcribed or found and
9 transcribed but don't show up in Table One.

10 And then this light blue really
11 are supplemental data that we'll discuss at
12 the end here which I felt because it did
13 provide a lot of data related to some of the
14 thorium facilities, I thought it might be
15 worthwhile to include here and discuss a
16 little later in regards to the last table.

17 Let's see, where were we here?
18 There are basically four types of sub-issues,
19 if you will, that kind of come up in reviewing
20 this data. The first really has to do with
21 record applicability, and this again gets
22 connected in a time line. The DWE reports are

1 basically for all out there data and there is
2 some portion of that is related to thorium.
3 The rest is related to uranium.

4 Now as Bob said, when in doubt,
5 the approach here is to high-side the dose,
6 and the way to do that is to use the dose
7 coefficients for Thorium-232 as opposed to
8 Uranium-234. And I did a little calculation
9 on my own using the ICRD database. And it's
10 just to verify using Class M and Class S of
11 the two different nuclides, and sure enough,
12 for type M, the ratio of thorium to uranium,
13 the range is from one to one up to about 560
14 for round surfaces. And there's a whole range
15 in between there. And the values for Type S
16 are very similar.

17 And this particular information
18 was also in table seven of our site profile
19 review back in November of '06, same basic
20 data structure. So even if we're not able to
21 get more granularity on the -- on the
22 production time line, we can always be fairly

1 confident that the doses will be claimant-
2 favorable.

3 Now one way we could actually get
4 a better handle on this, which might be kind
5 of labor-intensive, but it's worth bringing
6 up, is that if, you know, in Table One, which
7 was the time line of the thorium activity.
8 Now included in that, in addition to the time
9 of the activities, is the total production
10 quota in metric tons for -- by year. And so
11 we have that data. And now if we only had
12 some information on production capacities for
13 the various facilities and pieces of
14 equipment. It's my view that we should have
15 an idea of what a run time would entail, and
16 so we have at least a way to get down below a
17 yearly basis, maybe some fraction of a year.

18 Now I don't know if it's really
19 worth doing that or if it's, you know, there
20 would probably be quite a bit of labor
21 involved in that. But I'm just going to put
22 it out there as a potential way to increase

1 the resolution of our time line.

2 MR. MORRIS: John, we've learned
3 on -- the thorium capability was usually not
4 fully used, so they ended up campaigning
5 thorium.

6 MR. STIVER: Yes, so it would be
7 a short duration campaign.

8 MR. MORRIS: So because the
9 equipment was really sized for uranium in many
10 cases, and so the thorium was much smaller
11 mass moving through than uranium.

12 MR. STIVER: So it's very, very
13 solvent, except maybe in '55 when you have
14 that big campaign.

15 MR. MORRIS: Yes, so usually the
16 campaigns were short, and they stopped and
17 started multiple times during a year.

18 MR. STIVER: Well, I kind of
19 wondered about that because of the pilot plan.
20 And you can see that from '64 to '79 there's
21 always some flurry.

22 MR. MORRIS: But it didn't take

1 many days for them to do that. I think it's
2 a good suggestion. I just don't think it's
3 going to yield a lot of information.

4 MR. STIVER: Yes, it might be
5 something that's a lot of effort for the
6 results that might not really be that
7 practical in the long run.

8 MS. BALDRIDGE: This is Sandra.
9 I have a question.

10 MR. STIVER: Yes?

11 MR. KATZ: Go ahead, Sandra.

12 MS. BALDRIDGE: How do you
13 address the fact that there's no data for
14 Plant Six?

15 MR. STIVER: Actually, there is
16 data for Plant Six --

17 MS. BALDRIDGE: Well you said
18 there wasn't.

19 MR. STIVER: -- from '61 to '63.
20 This is some of that data that we didn't think
21 we had that turns out did show up. There is
22 data for 1961 through '63, and the next table,

1 table three, really gets to what data is out
2 there, what would be valuable for the
3 assessments of thorium, but really has not
4 been transcribed.

5 Now that was the kind of segue for
6 this next idea, which is really the record
7 availability, and as of now, only 32 of the
8 171 identified DWE records have actually been
9 transcribed. Well that doesn't sound like
10 much, but for our intents and purposes here,
11 if you go to table three, you'll see that what
12 we have here is a list of different
13 facilities, the reports that have been
14 transcribed for that particular facility, and
15 those that are not yet transcribed for years
16 of thorium production. And the ones that are
17 not yet transcribed I think summed to about
18 12. There's only 12 more that we need to get,
19 and so if we could -- I would say that if
20 we're going to grade or assign some priority
21 to a record transcription in order to get this
22 particular analysis clarified, that would be

1 the data set to concentrate on.

2 But if we can back up again to
3 table two. Another issue, kind of a sub-
4 issue, is this whole idea of the completeness
5 of the transcribed records. Now so far only
6 the job evaluation data, those line task items
7 have been transcribed into the spreadsheets.
8 Now the DWE reports obviously also contain the
9 DWEs for the jobs as well as for the entire
10 facility. And also it's not 100 percent clear
11 yet whether all the job evaluation data has
12 been transcribed for a facility that are
13 actually posted. I assume they are.

14 But I guess my question is do you
15 anticipate transcribing these other DWE
16 metrics into those particular --

17 MR. MORRIS: I'm not -- I want to
18 make sure I answer exactly the question you've
19 asked. Are you asking, are we going to go
20 farther back to find the original air samples?

21 MR. STIVER: No, no, not that.
22 But so far all that's posted are the task

1 items, the averages, the time for tasks, the
2 type of samples, so forth --

3 MR. MORRIS: Yes.

4 MR. STIVER: -- but the actual
5 DWEs aren't provided, nor is the DWE for the
6 entire site.

7 MR. MORRIS: Oh, but those --

8 MR. STIVER: -- but I was just
9 wondering if the --

10 MR. MORRIS: Well, my intent
11 would not be --

12 MR. STIVER: What source data are
13 you planning to use?

14 MR. MORRIS: And we'll just
15 recalculate it. It's probably easier and more
16 accurate for us to recalculate it with a
17 spreadsheet than that's the original take of
18 that.

19 MR. STIVER: Okay, all right. I
20 was just kind of curious as to where that was
21 going to go.

22 MR. MORRIS: I see the question.

1 I think we're going to stop where we are on
2 this.

3 MR. STIVER: Now we talked about
4 record availability here, and I guess the last
5 one is really this Titan sample. There's a
6 large amount of data that is provided to
7 support this, but as I said, there's only
8 about six to 25 percent is breathing zone; the
9 rest is general air.

10 And the reason I brought this up
11 is because there was considerable discussion
12 about this whole issue at the March 2008
13 meeting, and then actually in the NIOSH draft
14 response I copied out some text here. I think
15 it bears repeating.

16 And then their contention here was
17 that the uncertainties, particularly those
18 differences in breathing zone versus general
19 air samples, are compensated in TBD by
20 combining the data, which increases the data
21 spread. Basically, you've got a broader GSD.
22 By adding more data, you're increasing the

1 robustness of the sample size, but also by
2 using highly conservative assumptions for air
3 concentrations and model input. The intake
4 model includes the annualized thorium air
5 concentration values calculated at the 95th
6 percentile of the not normally distributed
7 thorium air samples for each year. This
8 results in a bounding estimate for intake that
9 is biased high in favor of the claimant.

10 Okay?

11 And a little later on here, it
12 says, NIOSH emphasized the important point is
13 there are clearly a large number of DWE
14 records that are available to be used to
15 reconstruct exposures in any manner deemed
16 sufficiently conservative --

17 COURT REPORTER: Sir, I need you
18 to keep your voice up.

19 MR. STIVER: Okay. On chronic
20 thorium exposures for all workers. And I
21 guess my -- this kind of gets more to the
22 issue of the white paper.

1 Now one of the action items, or
2 sub-action items in NIOSH's Action Item One,
3 is to explain how workers will be assigned to
4 low, medium, and high exposure potential.
5 That's basically on the type of position they
6 held, but I didn't see anywhere in the -- in
7 the co-worker model where he addressed the
8 paucity of data, as well, and how to high side
9 to compensate for that lack of data in certain
10 situations.

11 MR. MORRIS: You mean what a job
12 description actually says?

13 MR. STIVER: Yes, so here you're
14 saying that, well you know, it doesn't matter
15 if you have a mixture. You have more general
16 air samples that may not be use appropriate.
17 Because we've got to high side all of our
18 assumptions inside the 90th percentile. But
19 you add in the Technical Basis document -- in
20 your co-worker model, you can go to great
21 lengths to describe how are workers going to
22 be assigned to different categories based on

1 their exposure potential.

2 MR. MORRIS: I think that we need
3 to understand those comments in the context of
4 sequence. You know, the ones you just quoted
5 are before our most recent version of the
6 white paper, which has been informed by more
7 information as we've gotten it. In fact, the
8 information that you've presented this morning
9 on job descriptions and exposures, where the
10 mill man was the highest and a chemical worker
11 was second highest, I remember --

12 MR. STIVER: Okay.

13 MR. MORRIS: -- we'll take that
14 information and we'll fold it back in to
15 helping make that decision about whether a
16 worker is in that low, medium, or high
17 category.

18 MR. STIVER: I understand how you
19 did that. I mean, you go to great lengths to
20 categorize all the different job descriptions,
21 but in the situation where you have sparse
22 data, and so you try to compensate for that by

1 assigning somebody to a high level, that
2 automatically puts them into the high exposure
3 category.

4 Now how does that -- I guess I
5 didn't see there was any mechanism in that
6 white paper to address that particular
7 subject.

8 MR. MORRIS: Well, I'm not
9 exactly following you. That's my problem
10 right now, but we'll specifically deal with
11 that if you can give us a real concrete
12 example to work from, and I'll be happy to
13 take it --

14 MR. STIVER: I guess maybe
15 because this is older discussion and things
16 have taken place since then --

17 MR. MORRIS: Yes.

18 MR. STIVER: -- some of those
19 issues have been resolved.

20 MR. MORRIS: Perhaps but
21 nonetheless I think your comment is one that
22 if it didn't come through clear in our white

1 paper, we need to make it clear. And so if
2 you can give me a concrete example I'll be
3 glad to work with it. And we can do that
4 offline.

5 MR. STIVER: Okay, we can do it
6 offline.

7 MR. MORRIS: Sure.

8 MR. STIVER: Now let's see.
9 Well, you know, despite all this talk about,
10 you know, the appropriateness of general air
11 versus breathing zone samples, I think looking
12 at the actual DWE reports show that they
13 really are kind of a mixture and that they're
14 really appropriate to the particular task at
15 hand, so the reason -- another reason I
16 brought this up was that in looking at the
17 site profile there was a large discussion on
18 this, and the table presented showed this kind
19 of a plot of breathing zones versus general
20 air samples and how the GAs were consistently
21 low.

22 And I guess that would be

1 appropriate, if you're taking the two
2 different types of measurements of the same
3 basic task.

4 But it looks to me like this DWE
5 approach is pretty robust, and the data are
6 taken for the type of samples that's really
7 appropriate for that particular analysis. So
8 I don't really think that's an issue here, at
9 least as far as I've been able to tell by my
10 review.

11 I guess we could go on, if nobody
12 has any other questions about Tables Two and
13 Three. Look at Table Four. Table Four was
14 really a completely separate set of data that
15 Bob Barton had located on the HIS-20 database
16 back my second week of employment with SC&A,
17 where we naively assumed that this was the
18 thorium data, and this is all there was.

19 And so we downloaded this data,
20 and it turns out it's -- these are not
21 averages. We have the actual air sampling
22 data, and what we did is we went through and

1 cleaned it up and calculated some general
2 statistics, did some log-normal
3 transformations and some percentiles and the
4 distribution fits. And for each of those data
5 we summarized it by a total for year as well
6 as by each plant that's characterized per
7 year. We've got the number. And let me back
8 up one minute.

9 These are all breathing zone
10 samples. There's also a lot of general air
11 samples that went along with this data set.
12 At the time we were really concentrating on
13 the breathing zone. And the reason I included
14 this was because it looks like there are a
15 large number of these data that may be useful
16 in supplementing or at least validating some
17 of the DWE data.

18 Now, of course, this is contingent
19 on being a separate data set, and I'm not
20 quite sure whether this data was indeed some
21 of the raw data that went into creating the
22 DWEs in the first place.

1 Back in the March meeting there
2 was an extensive discussion about these 3,000
3 samples of thorium data. Now this may very
4 well be the same data set. I don't know if it
5 is or not.

6 MEMBER GRIFFON: Can you tell me.
7 I'm catching up a little here on this thorium
8 data, looking online and this may be a
9 question for NIOSH but you're saying the raw
10 data -- is this -- I know you approached a
11 bunch of things. I'm trying to go through
12 some of them now, like I say, catching up.

13 This says DOE raw data may contain
14 Privacy Act. Is that -- or DWE, I'm sorry,
15 DWE raw data. It's an Excel spreadsheet; is
16 that the one?

17 MR. STIVER: Correct.

18 MR. ROLFES: That would be the
19 DWE data. We basically had our data entry
20 team from ORAU go through each daily weight of
21 exposure report by year, by plan --

22 MEMBER GRIFFON: Okay.

1 MR. ROLFES: -- and extract

2 relevant --

3 MEMBER GRIFFON: But it's not raw

4 data?

5 MR. ROLFES: Yes, it is.

6 MEMBER GRIFFON: It's not the

7 sample data. It's the data from the report.

8 So it's the averages, and this goes back to

9 I'm having deja vu again, but it goes back to

10 my original question. You have a radon

11 sampling. You have a high of 64,778, a low of

12 eight, and you have an average. And I think

13 you're using the average for your modeling.

14 Am I correct, or you're getting -- actually,

15 those averages go into building a job -- for

16 each job.

17 MR. ROLFES: And so there might

18 be a very high concentration for a short

19 period of time.

20 MEMBER GRIFFON: Right.

21 MR. ROLFES: And so that's

22 factored into an overall --

1 MEMBER GRIFFON: Right, and this
2 is a 55-minute sample, so I'm assuming it's
3 that task, that one task or whatever, and then
4 they get an eight-hour for whatever job that
5 is, right?

6 It is interesting though to look
7 at these highs and lows that I think anyway,
8 because you sort of wonder what worker was
9 getting eight while the other worker's getting
10 64,000 doing the same thing.

11 MR. MORRIS: Well, they were on
12 different days. They were not --

13 MEMBER GRIFFON: Okay, so are we
14 talking about the DWE day? I hear my days but
15 they're supposed to be representing the same
16 task.

17 MR. MORRIS: I think you're
18 talking about air samples, aren't you?

19 MR. STIVER: We are talking about
20 the raw air sampling data.

21 MEMBER GRIFFON: We might be --
22 that's what I'm trying to figure out. I don't

1 want to be talking apples and oranges.

2 MEMBER ZIEMER: This is --

3 MEMBER GRIFFON: This is the

4 breathing zone?

5 MR. ROLFES: Correct. That would

6 have been the raw data that was basically

7 compiled into a single spreadsheet. That was

8 not the raw DWE data. These are raw air

9 samples --

10 MEMBER GRIFFON: The title is DWE

11 Raw Data.

12 MR. ROLFES: -- which may or may

13 not have been used in the daily weight of

14 exposure reports, so I don't know if these

15 were separate samples that were taken, in

16 addition to the daily weight of exposure --

17 MEMBER ZIEMER: Thirty-six were

18 the high, low, and average, so --

19 MEMBER GRIFFON: Right, right.

20 MR. STIVER: So those are

21 probably are the DWE.

22 MEMBER GRIFFON: This must have

1 come off the job sheets. And then you sort it
2 by task, it looks like because there's --

3 MR. STIVER: Yes, it's sorted by
4 task.

5 MEMBER GRIFFON: Yes, but then
6 there's year, plant and category, and this one
7 is sample prep operations. And then it tells
8 the operation --

9 MR. ROLFES: Yes, it kind of
10 looks like --

11 MEMBER GRIFFON: That's the
12 worksheet that it came from, yes.

13 MR. ROLFES: So it is in a daily
14 weight of exposure spreadsheet is what you're
15 saying, Mark? It's from the DWE?

16 MEMBER GRIFFON: Well, the title
17 -- the title that you -- that it is --

18 MEMBER ZIEMER: If you call it
19 DWE raw data.

20 MEMBER GRIFFON: DWE raw data,
21 yes. It's in your DWE white paper folder,
22 yes. It's in the DWE white paper folder, so

1 I don't know which one's which but there's
2 three spreadsheets and a white paper.

3 MR. ROLFES: That's correct and,
4 yes, that is extracted from the daily weight
5 of exposure report.

6 MR. STIVER: Those are the data
7 that you --

8 MR. ROLFES: Yes.

9 MR. STIVER: Okay, let's see,
10 where did we leave off here? Yes, Table Four.

11 Now like I say I posted this with
12 this other data set because I felt it might be
13 useful as a supplement or also as possibly a
14 -- another data set that may be used to
15 invalidate or benchmark the statistics that
16 were calculated based on the daily weighted
17 averages using actual results for a particular
18 facility and time.

19 Is Bob Barton on the line?

20 MR. BARTON: Yes, I am.

21 MR. STIVER: Bob, do you have any
22 more insights to where that data came from or

1 how it was related to the DWE data?

2 MR. BARTON: That first set that
3 we downloaded?

4 MR. STIVER: Yes, that first set
5 that we downloaded back on, I think it was
6 March 11?

7 MR. BARTON: It's how that was
8 originally intended to be used.

9 MR. KATZ: Bob, your voice is
10 breaking up. I don't know whether you're
11 using a speaker phone or --

12 MR. BARTON: Can you hear me okay
13 now?

14 MR. KATZ: Yes, that's better.
15 Thanks.

16 MR. STIVER: Yes, that's better.

17 MR. BARTON: Okay, to start over
18 again, I did not find any guidance as to how
19 those air samples were going to be used. The
20 original going in to try to find this data set
21 there, and that's why we originally go in that
22 direction.

1 MR. STIVER: Okay, it might be
2 worth our while to -- to, you know, do some
3 comparisons against the DWE data and just see,
4 you know, whether we can kind of get a match
5 up and see whether in light of what actually
6 might have been the source data.

7 And if not it could be pretty
8 useful as a supplement to what's already out
9 there.

10 MEMBER GRIFFON: Can I just ask -
11 - and I apologize. I had to step out and take
12 a phone call, so I might have missed this, but
13 -- or else we discussed it at previous
14 meetings and I'm blanking out on it, but the -
15 - when you say high, medium and low job
16 categories how are you assigning doses to each
17 one of those categories. What's the -- is it
18 a co-worker model with all this data in it, or
19 what's the constant?

20 MR. MORRIS: I don't have it open
21 but it's 16th percentile, 50th percentile --

22 MEMBER GRIFFON: Sixteenth, 50th

1 and 84th, something like that?

2 MR. MORRIS: I think that's
3 right, and one has variability and one's a
4 fixed number.

5 MEMBER GRIFFON: Okay, so it's in
6 the white paper?

7 MR. STIVER: Yes, it's in the
8 white paper.

9 MEMBER GRIFFON: And it's based
10 on the values populating that distribution
11 part of the average. Are they job averages or
12 what's populating that distribution?

13 MR. MORRIS: They're really
14 facility averages.

15 MEMBER GRIFFON: They're facility
16 averages.

17 MR. STIVER: Averages the DWE for
18 each job description.

19 MR. MORRIS: The reality is, you
20 know, we talked about it.

21 MEMBER GRIFFON: Each job or each
22 facility or what?

1 MR. MORRIS: The white paper has
2 probably more detail and I would put in it if
3 I were writing it again today. I described
4 how if you knew exactly the job description of
5 the person and how you can match a DWE report
6 for that facility --

7 MEMBER GRIFFON: Right.

8 MR. MORRIS: -- you don't have --
9 you can reduce your uncertainty side really
10 matching it up. But the reality is that most
11 of the time we won't have that.

12 MEMBER GRIFFON: Right.

13 MR. MORRIS: So what we would
14 then do is say here's the DWE spread for the
15 facility. It goes from -- a job description
16 has got this little of exposure.

17 MEMBER GRIFFON: So you have this
18 distribution for each plant, for each Plant
19 One, Plant Two, Three, and not necessarily --
20 or over --

21 Do you have different
22 distributions for different years or --

1 MR. BARTON: Yes, every year for -

2 -

3 MR. MORRIS: Every facility,
4 every year gets its own spread.

5 MEMBER GRIFFON: Okay, got it.

6 MR. MORRIS: And just to answer,
7 Mark looked this up for me a lung-exposure
8 potential is a constant at the 16th percentile
9 of the distribution. Medium is the 50th
10 percentile of what the GSD -- based on the
11 observed GSD for the data, and the high is
12 95th percentile.

13 MEMBER GRIFFON: Ninety-fifth,
14 okay. And -- I think that's it for now.

15 MR. STIVER: Okay.

16 MEMBER GRIFFON: Thank you.

17 MR. STIVER: Okay, we haven't
18 really gone into any analysis of the white
19 paper in any detail but because at this point
20 we're really trying to sort out the data --
21 the data granularity and veracity and
22 applicability, and I think once we have that

1 information in a situation we have a clear
2 picture of what data are available, where the
3 gaps are, then it might be more useful to
4 conduct a more systematic review if the
5 advisory board feels that that's appropriate
6 for the white paper and maybe come back with
7 some comments on that, as well.

8 But I think that going forward I
9 think the best thing to do is to probably get
10 those DWE reports that identify reports and
11 get those transcribed, and then we can
12 probably from that maybe do something similar
13 to what John did, maybe not to that level of
14 detail in assessing the granularity and where
15 the gaps may be.

16 MR. MORRIS: But I guess my
17 thinking is that's why we just went off and
18 did this demonstration, to show that our data
19 were going to be good enough. And, you know,
20 we know we can go transcribe that and apply it
21 to the white paper. The question is is that
22 going to be what we need to bound doses in the

1 SEC context.

2 DR. MAURO: Yes, I think that --
3 when you were summarizing the previous
4 meetings that it all started to come back. It
5 was not the original intention to load up
6 everything.

7 MR. MORRIS: Correct.

8 DR. MAURO: It was because of the
9 massive amount of material, we deliberately
10 picked selected years and buildings as being
11 good ones to represent the entire set, and if
12 those hold up well, those years and those
13 buildings, in terms of the ability to
14 recharacterize --

15 MEMBER GRIFFON: That's right.

16 DR. MAURO: -- these intakes --

17 MEMBER GRIFFON: It's coming
18 back.

19 DR. MAURO: Yes, it's coming
20 back. We'll stop. Now is that right now are
21 -- is the database complete with regard to
22 those years and those buildings?

1 MR. STIVER: For those years and
2 those buildings from Table Three, we're
3 halfway there, but there's not that many more
4 reports that need to be transcribed. I think
5 there's like 11 or 12 of them on there.

6 MR. MORRIS: I was under the
7 impression we have done all that.

8 MR. STIVER: Actually, the ones
9 that were requested were for '55 -- all
10 buildings for '55, all buildings for '66 in
11 Plant Six for 1960?

12 MR. ROLFES: Correct.

13 MR. STIVER: And I did not see
14 that that data was complete for those
15 facilities. That's why we decided to take
16 more of a generalized survey of what's
17 actually out there.

18 MR. MORRIS: I see.

19 MR. STIVER: You can see in Table
20 Two what's there for '55 and '66. There's
21 some gaps that have not yet been transcribed.

22 DR. MAURO: You know what, just

1 to help you a little -- looking at Table Two
2 the original plan was to have a complete set
3 for which plants?

4 MR. STIVER: A complete set for
5 all plants for the year 1955 and 1966. I
6 think in '55 you don't have Plant One. You
7 don't have Two, Three or Four --

8 DR. MAURO: Oh, okay.

9 MR. STIVER: -- or Eight or Nine.
10 You don't have any of those.

11 DR. MAURO: This is very helpful
12 the work group.

13 MR. STIVER: And the same for
14 '66. You have the same basic --

15 DR. MAURO: Where there's ground
16 that means that in order for us to do the
17 things that were asked of us to do, we still
18 need NIOSH to provide that information.

19 MR. STIVER: Yes, those reports
20 are available but haven't been transcribed.

21 DR. MAURO: They haven't been
22 transcribed.

1 MEMBER ZIEMER: So everything in
2 brown?

3 MR. STIVER: Everything in brown.

4 DR. MAURO: In other words, all
5 the plants in 1955, right?

6 MR. STIVER: All the plants in
7 1966, as well.

8 DR. MAURO: And all the plants in
9 '96, there will be no cross in '55 and there
10 won't be any place where I guess there is a
11 brown with an X in it. That means this is
12 something that exists but hasn't been
13 transcribed.

14 MR. STIVER: Hasn't been
15 transcribed, correct.

16 DR. MAURO: So '55 and '66, and
17 there was one more that you said.

18 MR. STIVER: Well, Plant Six in
19 1960. That was not included either. We have
20 '59 but we don't have '60.

21 DR. MAURO: So in theory if we
22 were going to continue on the path that we

1 originally laid out, that information would be
2 provided in the O drive. We would then go in
3 and do an analysis of that data.

4 MR. STIVER: That was the
5 original plan at the time. Now that still
6 doesn't really -- there are a couple of things
7 here.

8 To do that would require just as
9 much effort as it would to get those sheets I
10 indicated in Table Three for thorium, and by
11 doing that with the Table Three worksheets we
12 would then be able to have a clear picture of
13 the thorium issue, not necessarily the uranium
14 component but the thorium component because
15 for the same amount of effort they could
16 really bring this thing to a head.

17 DR. MAURO: A shift in plan to go
18 --

19 MR. STIVER: A shift in the plan
20 to -- rather than look at those original
21 plants --

22 DR. MAURO: Yes.

1 MR. STIVER: -- which had not
2 actually been done probably because for some
3 reason other parties came along and other data
4 was available initially. For whatever reason,
5 those plans were not transcribed, so to go
6 ahead and finish that out would be as much
7 effort when we look at the numbers of plants
8 that still need to be done as it would be to
9 go ahead and just, you know, get the ones that
10 we identified that pertinent to thorium.

11 DR. MAURO: The ones that you
12 feel --

13 MR. STIVER: The ones -- yes,
14 based on a time line.

15 DR. MAURO: And where would that
16 leave you?

17 MEMBER GRIFFON: I thought those
18 ones we picked originally were pertinent to
19 thorium, but we learned more about the
20 campaigns.

21 MR. STIVER: Yes, the more we
22 learned about it, we discovered a lot more.

1 MR. ROLFES: John, you were
2 mentioning that for 1955 the brown on Table
3 Two denotes that the report exists but we've
4 not transcribed it into a spreadsheet.

5 If you take a look we did send
6 three different -- three different DWE raw
7 data spreadsheets, and if you take a look the
8 spreadsheet that I'm looking at has 1955 Plant
9 One and it has DWE data. I'm not sure if
10 we're --

11 MR. STIVER: Okay, I got -- we
12 got two spreadsheets. We didn't get a third,
13 so maybe there is a third that has more of
14 this data available.

15 MR. ROLFES: There are three out
16 there, and let me point them out to you.

17 MR. STIVER: I don't have access
18 to --

19 MR. ROLFES: We have the DWE raw
20 data dash Privacy Act Information, Excel file
21 which is dated 03-24-2009. The Fernald DWE
22 raw data granularity, 04-16-2000.

1 MEMBER GRIFFON: That's the one I
2 showed you, yes.

3 MR. STIVER: There's one at 04-16
4 which is raw data by plant year.

5 MEMBER GRIFFON: And that was the
6 biggest one that had the most data.

7 MR. STIVER: Let me go back to
8 the actual data files here.

9 MEMBER GRIFFON: And then there's
10 an FMPC.

11 MR. ROLFES: That was the copy of
12 DWE for 04-16. And then there's, let's see,
13 the third one.

14 MEMBER GRIFFON: FMPC, DWE --

15 MR. ROLFES: Correct. And the
16 one that has the 1955 data would be the DWE
17 raw data dash may contain Privacy Act, so
18 there is a total of three that are available
19 out there. They were all added on March 24,
20 2009, to the advisory board.

21 No, I take that back. That is the
22 date that I put them on my disk. They are on

1 the advisory board review board.

2 MEMBER GRIFFON: They're on the
3 DWE white paper.

4 MR. ROLFES: And also with the
5 Microsoft Word file that describes the
6 approach. Three Excel spreadsheets and the --

7 MR. STIVER: We only have two of
8 those. The third one then only has that 1955
9 data.

10 MR. ROLFES: I think we've
11 completed the data transcription for really
12 more than we were tasked to.

13 MEMBER GRIFFON: So you think you
14 did all those --

15 MR. ROLFES: I think we did.

16 MEMBER GRIFFON: -- and SC&A just
17 didn't see that last -- or didn't get that
18 last sheet.

19 MEMBER ZIEMER: Well, maybe they
20 can work that out.

21 MR. STIVER: We can work that
22 out.

1 MEMBER ZIEMER: What needs to be
2 done on this job? What's the next step.

3 MR. STIVER: Well, the next step
4 I think is really to flush out the rest of the
5 thorium, the data that's pertinent to the --
6 Table Three, those particular sheets. If we
7 can get those we can really come to where we
8 have a clear picture of the data.

9 MR. MORRIS: And if I might
10 suggest, really you should be judging all of
11 the white paper approach, because that -- you
12 demonstrated today that there's a robust set
13 of data.

14 MR. STIVER: Oh, yes.

15 MR. MORRIS: And the real
16 question now is what are we going to do with
17 it. We made a proposal about what we're going
18 to do with it. And somebody needs to say yes.

19 MR. STIVER: I'm not a hundred
20 percent clear that it's -- that all the data's
21 available that we need.

22 DR. MAURO: Do we have a need for

1 a group of principles -- step for this
2 process, in other words a case and show how it
3 would be done. One of the things that's often
4 done is say, okay, we've got all these data.
5 There's a white paper describing how you're
6 going to do a dose reconstruction.

7 MR. STIVER: Why don't we just go
8 ahead and take that white paper and try it.

9 DR. MAURO: Try one out?

10 MEMBER GRIFFON: We have to kind
11 of test one. The question is do you have the
12 information that you're laying out.

13 MR. STIVER: Yes, yes, at this
14 point this is just a preliminary snapshot and
15 it's by all means not complete, but I believe
16 that would be certainly a logical next step
17 would be to --

18 DR. MAURO: Well, there would be
19 two different -- I mean, first of all does the
20 work group want to -- you understand where we
21 are now. Obviously, you have a sense of --
22 and it sounds like do you want us to continue

1 --

2 MEMBER GRIFFON: Yes.

3 DR. MAURO: -- and put a white
4 report out. And second do we want to stick
5 with the old plan, or do we want to go with
6 your recommendation. Let's go with Table
7 Three. Right now it sounds like that NIOSH
8 has loaded up all the data -- '55, '66 -- it's
9 there we just don't find it. And we can just
10 continue down the road we planned.

11 MR. STIVER: I guess the next
12 step really is to ascertain what's in that
13 third spreadsheet.

14 MR. ROLFES: Yes, the third
15 spreadsheet does include 1960 plant data,
16 1966. It's got several plants. The 1955 data
17 has several plants.

18 MR. STIVER: Okay, could you take
19 a look at the handout, Table Three, the DWE
20 report not yet transcribed? And can you see
21 that the third spreadsheet has these
22 particular reports.

1 MR. ROLFES: DWE report not yet
2 transcribed --

3 DR. MAURO: Yes.

4 MR. ROLFES: Okay.

5 MR. STIVER: I've got a plan for
6 '54, '56 and '66.

7 MEMBER GRIFFON: Oh, a pilot
8 plan?

9 MR. ROLFES: I have got roughly
10 1,500 data points in here so you're looking to
11 see if pilot plant for --

12 Okay, we've got 1955, Plant Nine.
13 Maybe it would be easier for me just to read
14 off --

15 MR. STIVER: Okay, so that's one
16 that we need right there.

17 MR. ROLFES: 1955, Plant Four?

18 MR. STIVER: Okay, that's another
19 one that we need.

20 MR. ROLFES: 1953, pilot plant?

21 MR. STIVER: Not really
22 pertinent.

1 MR. ROLFES: 1956, pilot plant?

2 MR. STIVER: We do have that,
3 good. That's one we need.

4 MR. ROLFES: 1960, Plant Six?

5 MR. STIVER: Yes, yes, we need
6 that one.

7 MR. ROLFES: 1966, Plant One?

8 MR. STIVER: Yes, we have that
9 one.

10 MR. ROLFES: 1966, Plant Eight?

11 And I don't know. I started in the middle
12 somewhere so let me reiterate. If -- I
13 apologize if I'm repeating myself here, but
14 1955, Plant One?

15 MR. STIVER: Got one at '55,
16 okay.

17 MR. ROLFES: 1955, Plant Nine?

18 MR. STIVER: We've got that, yes.

19 MR. ROLFES: 1955, Plant Four?

20 Have I repeated those?

21 MR. STIVER: You've repeated
22 those. 1955, I think you've already gone

1 through.

2 MR. ROLFES: Okay, so that -- any
3 other data.

4 MR. STIVER: Do you have anything
5 for '54 for pilot plant in Plant One?

6 MR. ROLFES: Let me take a look
7 in the other files here and check.

8 CHAIRMAN CLAWSON: I apologize,
9 but I guess I'm kind of confused on a path
10 forward. Are we going to continue on with --

11 MEMBER ZIEMER: Well, I would --
12 critique the white paper.

13 MR. STIVER: Yes, it looks like
14 just from what we see right now we have more
15 than half of what we thought was not yet
16 transcribed here, so I think we're well on our
17 way to be able to critique the white paper.

18 MEMBER GRIFFON: And the other
19 thing, and let Brad finish us off here, but
20 I'll send this updated matrix out to you
21 because I can tell you there's some things
22 hanging, like the later -- when you're using

1 in vivo for thorium. It's the later years.

2 MR. ROLFES: Yes, I think we
3 discussed that in pretty much detail at a
4 previous working group.

5 MEMBER GRIFFON: In here it says
6 action, so I just highlighted those. If they
7 come back and we all agree that it's closed,
8 that's fine. I'm just going to highlight
9 them, then the next time we meet we'll sort of
10 check those off and get rid of them.

11 MR. ROLFES: Do you recall what
12 the action might have been there?

13 MEMBER GRIFFON: Well, I have
14 several pages here, but --

15 MR. ROLFES: I want to make sure
16 that if there's something that we were asked
17 to do that we completed it.

18 MEMBER GRIFFON: It actually says
19 SC&A will review NIOSH white paper for the in
20 vivo.

21 MR. ROLFES: Just as far as I can
22 tell from everything that I have been

1 tracking, NIOSH has completed --

2 MEMBER GRIFFON: Yes, every
3 action.

4 MR. ROLFES: -- everything that
5 we've been asked to do.

6 MEMBER GRIFFON: So I'll just --
7 I'll highlight -- I think we just, you know,
8 we had certain high priority ones, then we had
9 some other ones. I just don't want to lose
10 track of the ones that might not have been on
11 people's radar, so I'll do that and Brad can
12 get it out.

13 CHAIRMAN CLAWSON: I appreciate
14 that, but on this thorium issue I want to get
15 my hands on where we're going. We're
16 proceeding ahead. As we previously stated,
17 SC&A is going to review NIOSH's white paper --

18 MEMBER GRIFFON: And complete the
19 data review.

20 MR. STIVER: Complete the data
21 review.

22 CHAIRMAN CLAWSON: Okay, did I

1 leave anything out on it or --

2 Okay, then that should conclude us
3 for today. Is there anything else that needs
4 to be brought up before we leave.

5 MEMBER GRIFFON: We're all tired.

6 MR. KATZ: Thank you, everyone on
7 the phone. The meeting is adjourned.

8 (Whereupon, at 5:45 p.m. the
9 above-entitled matter concluded.)

10

11

12

13

14

15

16

17

18

19

20

21

22

A				
ability 102:18 111:17 122:19 169:14 350:11 404:13	accomplish 17:14 17:15	activities 56:12 364:14 367:7 370:2 371:8 374:18 375:21 378:9	362:13,16	380:11 409:6,9 414:8 420:16
able 10:20 13:14 15:20 63:6,10 76:20 77:1,2,4,10 77:13,17 88:18 92:12 105:13 111:11 114:4 169:13 183:22 242:7 272:13 357:19 358:3 360:20 361:19 377:20 390:9 408:12 418:17	account 55:7 312:5 335:22	activity 22:5 295:1 354:1,7 375:20 378:7	adequately 185:5	air 306:5 314:22 315:3 318:16 319:1 320:13 336:6 347:6 348:19 354:17 362:12 363:6,7 365:1,13 367:19 374:14 375:8 382:20 384:9,19 385:2,4,7 386:16 389:10,20 390:21 391:10 394:18,20 395:8 398:19
above-entitled 199:14 303:18 421:9	accounting 150:13 268:2 365:20,20	actual 18:5 22:7 38:18 40:1 47:7 138:22 254:20 266:10 270:13 282:5 306:22 311:6 354:5 369:6 375:2 383:4 389:12 390:21 397:17 411:8	administrative 108:18	airline 247:8
absence 318:22 354:17	accumulate 345:5	Adams 2:10 8:10 8:11	admit 302:10 326:6	airplane 333:8
absolute 71:13	accumulated 263:22	add 127:10 128:2 245:15 280:15 283:22 291:22 303:5 324:19 386:19	adjudicated 211:14	Airport 1:15
absolutely 13:19 49:2,12 90:7 227:13	accuracy 149:11 197:18	added 151:7 153:18 411:19	advised 3:5,8 40:10 118:16 132:8 149:1 152:19 175:3 199:19 303:22 360:2 403:5 411:20 412:1	alance 262:4
Academy 326:20 327:1,16 328:22 346:9	accurate 26:9 166:5 260:13 298:13 375:19 383:16	adding 324:9 384:22	advisory 3:5,8 40:10 118:16 132:8 149:1 152:19 175:3 199:19 303:22 360:2 403:5 411:20 412:1	alert 176:10
acceleration 321:6	accurately 175:6 195:5	addition 15:2 21:1 165:11 313:15 361:9,18 378:8 395:16	AEC 223:2	Allen 2:14 7:21 8:1
accept 144:12 258:5 263:15 265:16 334:6	achieved 270:21	address 221:2 380:13 388:6	affect 102:18 259:6 335:22	allow 293:17
acceptable 278:15 310:7	acknowledge 86:2 104:9	addressed 386:7	affinity 341:17	allowed 293:6
acceptance 143:12 143:19 144:12 149:13	acknowledging 23:7	addressing 157:9	affirms 256:20	allows 72:3
accepted 230:17 261:11 266:14 301:12	acquired 149:16	adds 205:13	afternoon 11:11 199:18	alluded 88:14 350:10
accepting 233:14 283:7	Act 9:10 13:22 14:4 392:14 410:20 411:17	adequacy 17:16 196:20	aged 237:20	alpha 150:2 363:6
access 222:5 312:22 314:14 410:17	Acting 1:23 3:7	adequate 16:13,14 29:20 157:3 158:9 360:8,10 361:11	agenda 117:15	alpha-air 358:18
accident 158:11,16	action 45:14 109:10,14 112:13 119:7 129:12 131:5 136:12 144:11 154:12 302:18 351:14,21 355:20 359:7,12 359:16 361:8 362:8,9,19 372:9 386:1,2 419:6,12 420:3		age-old 351:10	alternative 306:20
	actions 114:22 119:6 297:7,15 350:7 352:17,19		aggregate 28:16,21 290:17	al-NABULSI 2:12 7:12,12
	activated 319:12 328:5,17		ago 105:9 263:18 305:14,16 359:6	amazed 86:20
	activation 281:1 320:1		agree 30:7 94:4 116:18 141:22 142:17 170:12 179:3 188:16 205:2 238:15 248:19 249:4 346:6 348:12 352:7 419:7	ambient 106:14
	active 86:22 91:19		agreeable 144:5	AMERICA 1:1
	actively 319:20		agreement 119:7 135:13	amount 22:5 27:1 38:9 96:20 99:21 100:2,3 101:5 103:16,20 166:6 222:7,11 237:20 252:9 264:3 275:21 292:13 293:19 334:22 335:15,22 337:9 361:4 364:4 367:5 384:6 404:9 408:15
			agrees 200:16	amounts 272:16,18
			ahead 75:18 187:6 259:11 276:1 334:19 337:11 346:18 358:1	

analyses 237:18 245:2	269:5,5 382:18 402:6	apply 33:18 35:22 35:22 36:2 86:9 90:2 267:17 403:20	argues 324:22 325:5	148:15 151:18 153:6 164:16 177:1 179:16 190:17,18 192:14 193:8 349:5 382:19
analysis 10:3 53:7 59:13 74:18 110:13 112:19 113:6 126:16 164:10 165:12 190:11 194:6 237:13 243:14,22 248:22 251:8 252:5,6 253:7,7 253:14 264:18 265:4 266:14 269:18 283:2 284:12 286:5,17 286:21 300:16 318:19 327:18,19 329:13 338:1 346:8 350:22 352:4 354:13 365:18 367:13 381:22 390:7 402:18 408:3	answered 47:19 answering 126:17 161:11 answers 158:8 253:1 270:2 anticipate 382:15 anxious 245:9 anybody 6:14 84:17 178:15 anymore 186:6 anyone's 294:11 anyway 41:2 107:18 113:9 114:7 120:16,17 124:14 127:5 128:6 146:16 189:19 206:14 313:16 317:6 358:11 394:7 apart 39:18 105:21 apologize 116:13 353:9 358:8 399:11 417:13 418:8	appreciate 118:20 347:2 355:19 357:19 420:13 approach 21:9 45:14 112:16 120:11 124:11 162:16 215:9 225:4 273:15 294:12 325:16,19 327:3,9,16 334:9 372:8 377:5 390:5 412:6 413:11 approached 392:10 approaches 267:10 appropriate 18:14 100:17 121:19 123:16 193:12 307:22 327:7 386:16 389:14 390:1,7 403:5 appropriateness 389:10 approved 339:5 approximate 71:10 approximately 38:14 157:13 331:11 April 1:13 316:8,19 aqueous 278:7 arbitrariness 71:6 area 59:11 86:16 209:22 210:4 257:14 342:1 345:7 365:8 373:11 areas 56:16 60:10 60:11,13,13 80:12 107:6 125:5 273:20 351:8 365:3 367:20 374:11,12 arena 93:17 137:15 argue 82:9	arguing 271:4 argument 139:17 186:4 258:15 291:19 294:2,7 344:5,7 arguments 280:11 297:9 334:13 arises 276:14 arising 286:1 Arjun 2:6 5:21 6:2 113:16 159:9 217:6 226:15,17 227:8 228:15 230:4 255:8 264:22 265:11,21 266:13 276:17 286:12 287:5 288:3 295:16 300:12 302:2 arms 15:1 arose 173:12 array 28:7 arrows 317:15 article 322:6 artificially 79:14 ascertain 415:12 ash 246:8,10 247:1 250:19 262:21 284:7 291:1 aside 62:13 asked 17:13,17 64:17 75:21 96:6 96:18 115:3 126:18 128:21 155:14 198:14 200:5 215:7 263:14 305:16,19 305:22 306:2 308:2 382:19 406:17 419:16 420:5 asking 12:21 30:19 90:11 92:6 93:18 95:21 137:8 143:11 147:18	aspect 14:1 188:14 assess 186:21 assessed 289:8 assessing 363:3 403:14 assessment 93:8 112:20 120:9,15 182:11 306:20 307:15 335:14,21 assessments 381:3 assign 20:16 23:6 39:6 70:12 81:3 110:22 125:7 136:3 231:9 349:22 356:22 357:2 381:20 assigned 73:8 81:20 348:15 363:14 386:3,22 assigning 28:20 226:7 348:3 350:19 388:1 399:16 assignment 351:6 associated 23:9 66:10 164:18 165:1 287:17 326:9 349:15,16 364:14 374:18 assume 20:9,11 22:7 100:5 103:9 103:13 104:6 216:3 231:5 234:8 271:22 290:4 299:21 323:11,19 331:16 340:2 344:17,22 366:16 382:13 assumed 21:4,5 234:10 265:18 271:13 290:3
analytical 149:18 243:13 263:11 365:18 analyze 261:5 analyzed 74:1 166:6 261:6,10 263:8 264:13,14 278:14 284:10 annual 68:6,9 149:19 178:18,19 178:22 179:19 180:11 204:12 205:10 annualized 385:4 annually 180:11 195:7 202:20 Anspauth 2:6 6:5,5 answer 21:11 59:1 62:22 64:17 66:17 87:9 117:11 124:2 145:16 159:18 162:1 169:19 178:5 179:17 181:20,21 188:9	apparent 322:22 appear 185:10 appears 112:6 235:17 250:16 256:15 296:10 331:3 appendix 243:14 253:10 255:2 300:15 309:7 314:11 322:5 329:7 332:9 368:10,11 apples 395:1 applicability 376:21 402:22 applicable 270:20 application 85:4 121:11 314:20 applied 86:5 183:13 216:2 285:18 356:21	approached 392:10 approaches 267:10 appropriate 18:14 100:17 121:19 123:16 193:12 307:22 327:7 386:16 389:14 390:1,7 403:5 appropriateness 389:10 approved 339:5 approximate 71:10 approximately 38:14 157:13 331:11 April 1:13 316:8,19 aqueous 278:7 arbitrariness 71:6 area 59:11 86:16 209:22 210:4 257:14 342:1 345:7 365:8 373:11 areas 56:16 60:10 60:11,13,13 80:12 107:6 125:5 273:20 351:8 365:3 367:20 374:11,12 arena 93:17 137:15 argue 82:9	arguing 271:4 argument 139:17 186:4 258:15 291:19 294:2,7 344:5,7 arguments 280:11 297:9 334:13 arises 276:14 arising 286:1 Arjun 2:6 5:21 6:2 113:16 159:9 217:6 226:15,17 227:8 228:15 230:4 255:8 264:22 265:11,21 266:13 276:17 286:12 287:5 288:3 295:16 300:12 302:2 arms 15:1 arose 173:12 array 28:7 arrows 317:15 article 322:6 artificially 79:14 ascertain 415:12 ash 246:8,10 247:1 250:19 262:21 284:7 291:1 aside 62:13 asked 17:13,17 64:17 75:21 96:6 96:18 115:3 126:18 128:21 155:14 198:14 200:5 215:7 263:14 305:16,19 305:22 306:2 308:2 382:19 406:17 419:16 420:5 asking 12:21 30:19 90:11 92:6 93:18 95:21 137:8 143:11 147:18	aspect 14:1 188:14 assess 186:21 assessed 289:8 assessing 363:3 403:14 assessment 93:8 112:20 120:9,15 182:11 306:20 307:15 335:14,21 assessments 381:3 assign 20:16 23:6 39:6 70:12 81:3 110:22 125:7 136:3 231:9 349:22 356:22 357:2 381:20 assigned 73:8 81:20 348:15 363:14 386:3,22 assigning 28:20 226:7 348:3 350:19 388:1 399:16 assignment 351:6 associated 23:9 66:10 164:18 165:1 287:17 326:9 349:15,16 364:14 374:18 assume 20:9,11 22:7 100:5 103:9 103:13 104:6 216:3 231:5 234:8 271:22 290:4 299:21 323:11,19 331:16 340:2 344:17,22 366:16 382:13 assumed 21:4,5 234:10 265:18 271:13 290:3

318:14 337:9 390:17 assumedly 319:15 assumes 300:19 assuming 21:1,17 29:5 51:18 53:3 241:14,15 255:3 274:12 288:21 289:10 293:1 298:13 323:18 331:4 394:2 assumption 21:8 21:20,22 215:11 215:17 216:1 259:18 272:21 330:6 334:2,22 assumptions 50:10 271:20 280:1,10 314:3 323:9 325:9 325:11 337:18 347:10 385:2 386:18 assure 14:3 230:7 355:5 assured 197:4 asymmetrical 333:8 atoms 331:5 attach 341:22 Attachment 27:8 51:1,13 64:19 75:13 322:5 attachments 51:2 attempt 52:18 319:8 320:6 attempted 309:12 attention 45:2 71:15 249:10 250:19 299:13 attributes 149:15 audit 192:15 193:17,20 audits 168:12 180:3 authorized 305:18 automated 92:12 96:10,10	automatically 23:19 388:2 autopsy 102:16 availability 142:8 362:5 372:16 381:7 384:4 available 11:6 111:6 113:14 138:7 146:11 151:15,20 153:14 153:19 267:2 277:22 278:11 282:13 359:1 360:17 375:1 376:7 385:14 403:2 406:20 409:4 410:14 411:18 413:21 average 68:13,15 68:19,21 69:1,8 69:21 247:19 284:8 287:1,2 299:18 311:9 313:13 317:1,8,20 319:6,7,11 347:11 363:2,22 364:3,6 367:15,19 374:4 393:12,13 395:18 400:11 averages 159:4 373:7,9,19,20 374:11 383:1 390:21 393:8,15 397:17 400:11,14 400:16,17 avoid 327:22 aware 218:10 255:11 awful 328:5 A-1 249:20 a.m 1:16 3:2 40:7,8 118:14,15 A/B 134:22 <hr/> B <hr/> B 64:19 75:13 311:3	back 33:15 39:9,10 43:17 45:4 47:13 60:9 78:16 80:10 84:19 93:1 96:9 97:9 101:7 105:4 105:12 107:10 108:4,16 109:7,10 109:16 118:12 119:14 124:22 125:10,11 127:20 132:5,19,21 133:13 136:12,19 141:21 146:6 148:7 154:19 155:3 156:6 157:4 162:2 163:19 166:9 169:9 170:17 171:13 185:13,16 187:20 188:6 189:12 198:11 200:4 206:5 207:14 219:9 221:19 223:1 224:4 225:14 228:15,19 232:11 237:1 244:9,18 245:22 256:7 257:1 258:17 261:13 263:16 268:4 270:13,17 282:19 297:4,16 303:15 304:2 308:2 318:1 319:2 326:13 327:17 330:1,12 343:10,12,16 348:11 350:3,17 356:5,15 357:20 359:10,13 370:19 370:22 377:19 382:2,20 387:14 390:16 391:7 392:1 393:8,9 398:5 403:6 404:4 404:18,20 411:7 411:21 419:7 background 262:3	297:13 318:21 354:16 bad 189:17 288:18 badge 170:21 182:22 183:18 187:7 191:15 badges 187:5 207:5 badging 84:12 balance 220:22 229:13 236:1 262:8 283:19 284:6 285:2 301:17 302:5 balanced 259:9 Baldrige 2:15 6:21 8:5,5 12:17 98:20 99:1 100:11 100:15,19 101:7 101:10,12,21 380:8,12,17 ball 34:4 ballpark 168:8 barometric 313:12 314:2 barrel 261:20 299:6 barrels 245:13 barriers 335:2,7 347:16 Barton 2:9 6:19,19 51:10,11,15,22 64:14 65:1,9 113:16,17 127:10 390:15 397:19,20 398:2,7,12,17 402:1 base 168:6 277:17 based 11:9 35:13 37:3 59:13 71:20 78:19,19 86:13 99:11 100:19 104:15 111:1 113:2 169:2 207:22 222:1,14 225:5,6 230:19,21 237:13 241:6 242:20 272:10	278:2 279:3 281:18 285:15 313:22 325:20 337:7 348:3 351:17 354:22 368:4 372:9 386:22 397:16 400:9 402:10 409:14 baseline 319:10 basement 345:4,16 basic 363:21 377:19 390:3 406:14 basically 16:16 18:4 19:16 20:5 25:4 27:13 57:15 121:6 127:17 137:2 178:10 197:13,17 200:19 221:16 310:4 320:19 321:19 322:14 324:21 325:6 330:22 333:7,11 334:20 339:10 340:7 348:1 354:3,18 355:15,19 360:5 362:10 363:17 366:9 372:22 373:22 375:7 376:18 377:1 384:21 386:5 392:19 395:6 basis 106:20 175:18 268:9 271:7,14 273:20 283:20 289:1 320:5 321:9 324:1 337:16,21 338:21 339:6 350:15 378:17 386:19 bat 35:4 85:10 271:21 batches 274:8 bean 192:4 bears 384:15
--	--	---	---	---

Beatty 2:13 7:17,17	414:15	286:22 288:22	42:22 45:8 51:13	bolded 373:2
bed 102:17 161:1	believes 274:1	289:20 290:13	63:9 81:1,2	bomb 364:18
191:3,4	belly 198:3	298:6 299:16	102:14 111:9	Bonnie 99:13,14
beds 315:1	benchmark 397:15	bioassay 16:16,17	112:22 120:19	books 146:11
beginning 3:14	bend 336:12	19:12,13 27:20,22	163:9,13 198:11	boot 243:22 248:22
24:20 27:9 36:20	benefit 123:5	28:3 29:6 30:12	198:12,18 204:7	249:6,7 250:4,6
130:3 225:12	314:13	33:4,8,14 34:2,3	221:10 224:15,15	250:13 251:14,15
234:9,9 261:17,19	bentonite 342:18	34:18,20 35:2,10	232:6 245:13	252:5 253:8
309:9 329:19	best 37:3 83:19	36:1,2,7,11 37:12	250:8 252:7	264:17 269:1,3,6
334:21	116:8,15 117:10	44:4,10 48:21	301:12 326:16	269:17 290:19,20
begins 215:18	196:6 211:12	49:1,5 50:2,8,20	353:1 372:18	291:8 300:16
337:18	277:18,21 278:10	51:21 55:8,15	378:20	born 341:17,18
behalf 2:13 7:18	278:18 403:9	57:2,5,10 58:3,7	bi-weekly 207:5	342:1
283:13	beta 150:3 237:17	58:13 59:7 60:7	blank 200:20	bottom 121:20,21
behaves 101:2	279:3 281:21	61:3 62:5 63:13	blanking 399:14	214:14 216:16
Behling 2:8,10 6:15	282:10	64:7 82:15 83:12	blast 340:8	251:5 259:4,7
6:15,18 12:19,20	better 50:5 69:12	84:21 87:12 89:15	blended 245:11	267:5 270:5
13:10,13 14:3	70:2 105:13	90:18 91:7 92:4	246:10 264:12	273:22 304:22
102:8 169:5,7,17	220:18 360:4	92:15 93:20,21	278:12 289:22	311:4,16 312:16
170:2 195:15,16	378:4 398:14,16	95:10,11,18 96:17	298:7	317:15,17 318:4
195:18 196:4,17	beyond 232:20	97:6 98:4 99:3,20	blending 244:19	336:7 337:14
196:18 199:4	260:16 285:11	103:21 105:5	blends 21:18	bought 334:1
200:9 206:16	bias 52:19 207:19	106:12 107:15	blow 203:9	bounce 142:2,3
213:4 304:22	208:11 212:8	110:2,3,6 113:18	blue 57:21 58:2	bound 28:15 41:11
305:9 306:17	biased 53:8 82:4	113:22 114:1	376:6,10	121:12 179:13
307:7 312:13,17	385:9	119:9 121:1,5	board 3:5,8,14,15	293:16 357:8
327:21 330:21	big 32:4 71:13	122:8,18 123:5	4:9 21:4 40:10	403:22
331:7 332:22	120:7 141:9 160:1	124:8 128:13	45:5 110:3 115:17	boundaries 14:8
339:18 340:20	161:18 163:6	138:22 139:2,17	118:17 132:8,18	bounding 21:9
341:10 343:19	181:18 186:1	149:3,9,22 150:19	149:1 175:4 176:4	44:20 100:9
345:2 353:21	192:8 194:3	153:8 157:15	179:4 198:8,13	104:14 112:16
354:6	262:21 263:13	158:5,9 165:14	199:19 220:13,19	113:4 116:1
believe 9:18 16:3	290:18 321:15	176:19 182:21	220:20 283:3	120:10 280:10
19:18 24:22 35:12	349:6 371:18	183:6,18 184:4	303:22 360:2	294:6 385:8
46:15 65:9 87:3	379:14	186:3 188:18	403:5 411:20	box 261:14
87:22 96:22 97:7	bigger 189:1	191:15 192:22	412:1,1	BR 239:7
102:7,7,10 110:19	207:10	196:22 201:7,18	Board's 152:19	bracket 106:16
115:1,5,7,11	biggest 411:6	215:19 246:21	Bob 2:9 6:19 51:10	Brad 3:19 9:12
124:6 125:2	billion 241:4,9,16	259:8 271:16	64:13 113:11,13	200:1 333:13
132:16 134:15	241:19 243:4	272:2,11 298:17	113:15,15,17	418:19 420:11
146:6,8 151:16	244:2 247:17	bioassayed 58:16	126:21 358:5,16	Bradley 1:16,19
175:8 190:2	250:17 251:10,22	58:19,21 81:21	366:22 377:4	break 106:22 109:9
192:13 216:21	253:21 259:13	bioassays 84:6	390:15 397:19,21	117:13 118:19
278:16 326:7	268:8,12,15	203:20	398:9	132:4 198:17
332:7 333:1 334:6	272:21 273:19	biological 23:9	Bob's 209:5	199:2 205:18
340:21 345:18	274:2 279:11	bird's 72:4	body 102:22	302:16 303:12
347:6 350:4 362:1	281:9 284:9	bit 10:2 25:16,18	295:14	304:3 346:14

breaking 199:9 209:18 303:16 364:17 398:10	355:6 building 28:9 56:15 63:3,14,15,15 65:5,22 66:7,22 69:17 76:7,12 83:11 85:9 87:14 110:16 112:11 119:18 139:7,9 193:13 208:18 349:17,18 367:1 375:8 393:15	397:16 calculation 100:1 308:12 325:1,2 337:13 344:9 377:8 calculations 104:18 295:8 330:17 339:2 365:6 call 3:14 9:6 85:8 86:8 130:9 154:17 185:17 198:17 199:5 208:13 244:6 299:12 338:2 396:18 399:12 Callaway 2:14 7:21 7:21 called 24:8 51:17 59:9 78:3 80:7 200:9 219:3 235:4 235:12 253:15 306:19 336:17 372:10	28:2 137:3 153:18 296:21 cards 133:20 149:19 369:8 care 12:8 93:21 116:11 252:9 careful 245:10 carefully 21:7 223:6 261:14 308:16 carry 74:8 carryover 129:18 129:19 case 20:4 28:17 36:3 89:10 106:7 107:16 114:19 122:22 123:4 138:22 158:11 159:7 162:22 183:2,15 185:8 189:14 191:13 194:12,15 202:11 233:3 241:7 272:15 276:2 283:9,9,16 284:14 284:15 291:1 295:5 317:4 369:20 414:2 cases 33:8 37:22 79:21 81:14 82:17 90:11,21 91:1,3,4 92:8 93:11 97:5,8 109:17 110:2 119:9 122:17 124:16 138:17 159:13 160:13 169:12,21,22 170:4,5 176:15 177:11 178:4,6,20 183:12 184:1 188:14 193:16,19 195:7,9,21,22 196:2,5,15,16 198:20 200:11,13 202:6 205:22 206:3 207:10,21 212:21 248:18	249:4 251:16 272:4,6,13 291:2 291:3,8,10 379:10 case-by-case 106:20 175:18 176:2 catch 39:11 128:4,6 catching 392:7,12 Catch-22 114:2 categories 16:14 28:4 29:1 33:15 34:9,10 38:9,13 38:19,19 49:21 62:2 77:21 79:19 85:1 89:14 90:4,6 108:17 120:22 121:2,3,12 127:3 160:14 161:4 162:14 167:12,19 167:21,22 168:3 180:9,21 181:2 361:13 386:22 399:16,17 categorize 387:20 category 29:6 53:7 78:2 80:6 85:10 85:13 94:11 108:20 111:11 122:7 125:12 139:9 184:6 191:16 204:13 363:4,12 364:8 387:17 388:3 396:6 CATI 114:11,12 caught 147:9 causation 38:7,12 89:8,11,22 91:15 91:18 92:2 123:3 267:15 270:22 272:14 cause 101:19 caution 196:20 CD 193:16 CDs 211:7 ceiling 317:13 cell 337:5
breath 10:3 breathing 306:4 363:8 364:13 365:8 373:11,16 373:17,21 375:7 375:11,15 384:8 384:18 389:11,19 391:9,13 395:4 brevity 324:8 Breyer 12:16 brief 99:4,6 304:3 305:21 346:18 358:12 367:10 briefing 306:12 briefly 40:12 276:18 bright 181:4 bring 14:10 52:16 127:20 250:14,16 297:2 408:16 bringing 378:5 brings 121:1 broad 195:7 236:16 broader 384:21 broke 207:2 broken 199:22 207:2,6 248:15 brought 47:12 101:13 156:12 245:6 344:6 370:19,22 384:10 389:16 421:4 brown 375:22 407:2,3,11 410:2 Bryce 2:4 5:2,6,7 5:11 219:18 221:7 232:1 234:19 238:1,22 246:10 257:20 262:2 292:15 295:1 298:21 budget 172:20 build 26:21 29:22 221:21 343:16	buildings 16:13 18:9 28:5 29:1 49:21 56:15 62:17 66:13 70:7,10 76:1,3,5 77:11 79:19 110:14 111:14 114:13 127:18 161:4 208:19 404:10,13 404:22 405:2,10 405:10 build-up 341:1 bump 289:14 bunch 236:21 288:15 392:11 burden 356:11 burdensome 187:22 buried 244:17 burner 356:6 business 276:22 button 8:11 9:2,4,5 <hr/> C <hr/> C 3:1 311:3 cafeteria 365:3 374:20 cake 337:4 calcite 370:9 calcium 315:1 364:19 calculate 36:5 79:7 192:9 267:12 364:1 calculated 23:5 313:7 385:5 391:1	calling 232:8 calls 131:1 campaign 366:6 379:7,14 campaigning 379:4 campaigns 270:8 273:21 281:14 282:22 343:3 379:16 409:20 Canberra 149:8 cancer 19:21 20:3 37:22 38:5 89:6 89:10 90:1 91:1 93:14 267:13 cancers 89:6 349:13 357:15 cap 342:16,18 343:3 capability 335:17 379:3 capacities 378:12 capture 67:4 149:16 183:1 captured 15:20		

cells 337:3	chamber 282:11	156:5,8 278:1	cited 38:1 89:6	clarity 136:17
center 149:10	chance 37:11 189:7	chemical 80:8	102:9	class 60:15 71:10
CENTERS 1:5	196:9 249:11	85:20 86:21 88:4	citing 300:11	71:15 86:9 103:6
certain 4:8 19:20	322:7 346:14	90:7 106:2,4,10	claim 41:5 89:7	377:10,10
22:7 42:19 44:9	366:21	108:21 125:4	94:16,21 97:3	classes 33:16
101:5 180:9,10,10	change 59:5,14,17	127:6,14,19	106:19 123:1,6	170:18
201:19 211:9	59:18 60:11	179:10 181:6	155:16 172:20	Claude 322:6
259:20 285:12	127:12,20 135:18	197:10 224:17	267:14 270:20	Clawson 1:17,19
308:18 316:6	205:6 259:18	276:21 277:16	claimant 49:4 54:9	3:19,19 9:14
323:8 329:18	337:15	278:9 368:22	71:16 241:17	10:12 11:13,16,21
347:10 386:9	changed 126:14	387:10	273:15 274:12	12:3,7 14:9,18
420:8	278:3 279:8,19	chemistry 280:19	285:17 301:19	15:14,18 51:3
certainly 14:1 59:9	280:20 365:15	chloride 364:19	378:1 385:9	102:20 103:18
83:15 88:7,21	changeouts 201:9	Chmelynski 2:9	claimants 30:15	115:19 117:16
97:18 104:11	changes 150:10	6:21 7:1 65:11,16	33:5,6 34:1 49:5	118:5,20 119:10
129:20 147:3	309:4 313:13	65:18 67:17 68:12	90:18 116:5 117:4	119:13 129:9,13
154:17 172:18	changing 97:16	68:21 69:2 95:20	117:8 123:10	129:17 131:3,7,10
196:11 209:8	183:8	96:3 138:9,13	125:20 156:3,18	131:16 132:1
230:8 324:10	chapter 235:8,12	139:3,10 143:10	157:2	136:6 146:17
414:16	256:14,21 257:11	154:10,15,22	claimant's 40:1	198:2 199:7 200:2
certainty 357:8	257:11	166:16 167:1	claimant-favora...	210:21 214:7,17
certify 177:12	characteristic	168:7 194:16,20	44:20 103:5 197:5	292:10 296:2
cesium-137 282:1	263:21	194:21 195:1,14	claiming 53:17	297:1,11 302:14
cetera 63:14 130:5	characteristics	213:11,15 249:13	62:10	302:20 303:11
249:18 285:18	86:14	269:9,12,22	claims 37:16,18	304:4 333:18
316:16	characterization	choice 85:11	38:5,11,15 39:7	353:5,22 355:17
Chair 3:16,19,20	87:20	332:16	39:21 88:15,22	356:13 357:9,18
9:14 10:12 11:13	characterize 63:19	choose 75:1 323:1	89:10 91:6,9,17	418:8 420:13,22
11:16,21 12:3,7	107:11 108:5	chose 187:20	92:1,22 110:2,6	clay 342:18
14:9,18 15:14,18	375:17	CHP 305:12	111:17 113:21	clean 12:5,8 59:9
51:3 102:20	characterized	chronic 36:6 41:11	122:3 162:3 167:7	cleaned 277:20
103:18 115:19	262:18 265:20	53:3,4 100:10	171:4,5,12,16	391:1
117:16 118:5,20	333:22 334:3	105:18,19 179:12	172:13 211:14	clear 10:19 55:19
119:10,13 129:9	391:6	272:1 385:19	270:19 273:4,5	131:3 153:22
129:13,17 131:3,7	charcoal 315:1	chronically 290:12	348:17 357:16	183:14 204:9
131:10,16 132:1	charge 341:19	Chu 305:5 324:21	clarification 23:2	210:20 279:19
136:6 146:17	charged 341:17	333:15 334:3,9	35:21 47:22 51:4	320:13 332:10
198:2 199:7	chart 176:13	chunks 185:11	74:21 125:17	372:11 382:10
Chairman 1:17,19	chartered 302:6	Cincinnati 1:15	127:11 214:18	388:22 389:1
200:2 210:21	check 26:15 147:5	329:14	231:10 244:10	403:1 408:12
214:7,17 292:10	147:14,18,19	circled 51:9	clarified 224:7,12	413:8,20
296:2 297:1,11	158:1 212:12	circular 55:4	224:21 225:1	clearance 307:3
302:14,20 303:11	418:7 419:10	circulated 216:5	226:21 381:22	cleared 10:11,15
304:4 333:18	checked 148:13	circumstance	clarify 72:16	11:4,7,14,15,16
353:5,22 355:17	325:13	251:19 283:10	120:18 204:7	12:11 13:1,8 16:4
356:13 357:9,18	checking 4:8	300:5	218:11 236:6	224:19 225:21
418:8 420:13,22	chem 77:9 94:7	cite 134:14 239:15	304:5 330:16	226:2 237:11

304:21 307:4,5 319:16 clearly 155:9 200:6 241:9 293:14 311:13 312:6 371:21 385:13 clerks 86:16 clients 361:6 close 135:6 201:12 296:8 297:8 318:15 321:8 353:2 closed 419:7 closer 145:20 closing 15:18 351:22 closure 118:22 code 336:17,20 337:13 347:9 coded 96:22 372:17 coding 96:17 coefficients 325:10 347:11 377:7 cohort 84:12,12 126:1 collect 152:2 collected 51:21 66:1 104:22 105:1 105:5 165:15 166:2 184:4 201:7 201:10 266:15 369:18 collecting 72:2 collection 145:2 collectively 336:13 color 57:21,21 372:17 colored 66:21 224:9 373:3 column 48:2 51:17 201:1,4 241:2 277:1,6 310:21 316:17 322:13 372:20 columns 23:4 218:7 228:2 280:20 311:8 317:12	372:21 combining 384:20 come 16:9 23:2 50:5 54:2,18 80:19 81:15 86:6 109:10 117:4 118:7,22 124:22 125:10 138:10,14 141:21 143:9 147:6 178:20 198:11 207:14 216:8 238:12 242:14 249:9 252:6 263:4 274:10,11 286:22 287:3 289:5 301:21 319:17 330:19 333:3 339:15 347:12 355:13 376:19 388:22 396:1 403:6 404:4 413:7 419:7 comes 42:6 76:15 129:21 136:4 215:12 224:11 245:22 309:6 316:2 332:7 354:12 comfort 303:12 comfortable 21:21 22:15 coming 116:22 131:11 189:8 246:7 253:2 304:8 305:1 341:6 404:17,19 comment 56:7 73:22 222:19 225:4 243:9 388:21 commentary 215:4 comments 118:21 220:5 225:18,22 279:16 387:3 403:7 commissioned	326:20 commitment 141:4 192:8 committee 326:22 327:3,5,9 common 344:5,7 344:16,16,21 362:12 communicating 56:1 company 42:18 comparable 137:20 compare 68:8 69:12 compared 41:19 47:8 68:13,16 69:9,20 76:2 185:11 189:9 237:20 295:9 325:21 345:16 349:9 comparing 58:1 71:11 107:4 165:12 comparison 23:13 37:16 69:5,12 71:3 149:2 150:17 150:19 156:5 166:1 comparisons 24:1 399:3 compatible 26:13 compelling 241:6 291:18 compendium 55:13 compensate 386:9 387:22 compensated 349:14 357:17 384:19 compensation 259:6 compensatory 272:9 compiled 166:2 395:7 compiling 65:11	complete 19:12 26:9 50:6 155:18 156:3 157:7 177:13 201:20 269:21 313:15 404:21 405:14 406:2,4 414:15 420:18,20 completed 91:10 91:11,14 123:1 167:16 175:16 182:4 187:1 272:7 272:8 412:11 419:17 420:1 completely 55:18 116:18 195:2 390:14 completeness 16:11 16:12 17:16 39:14 41:4,5,17,22 43:14,22 44:10,12 44:18 45:3,10,11 46:21 117:20 124:19 149:11 155:4 156:20 159:11 161:12,15 163:10,15 166:9 168:17 169:14 174:10,18 175:1 175:14 190:5 201:13 382:4 completion 131:9 complex 143:7 223:9 257:8,15 265:6 303:8 313:21 complicated 372:14 component 408:14 408:14 components 268:3 337:3 composite 323:3,6 composition 197:9 280:21 292:6 comprehensive 201:16	computer 42:21 219:11 256:19 309:1 312:22 336:17,20 concentrate 103:14 382:1 concentrating 391:12 concentration 241:3 246:15 265:15 318:18 358:18 363:6 364:3 365:3,14 385:5 393:18 concentrations 246:12 249:9 255:15 260:7 284:8 294:12 318:16 367:19 368:9 385:3 concept 17:8 31:10 104:2 346:11 concepts 362:21 concern 20:1,19 28:6 97:12 112:3 122:7 190:21 215:8 238:4 282:3 concerned 96:21 125:22 132:14 163:21 264:15 340:11 concerning 95:21 concerns 9:10 22:13,16 157:5 191:1 314:6 330:4 330:8 concerted 43:5 370:4 conclude 332:16 421:2 concluded 307:21 320:5 321:9 324:3 421:9 concludes 327:5 conclusion 74:11 76:10 122:16 288:8 304:6
--	---	--	---	--

319:18 329:5 333:2 conclusions 56:2 67:6 207:15 concrete 388:11 389:2 concur 329:5 condition 345:21 conduct 403:4 confidence 44:8 167:4 225:7 233:22 confident 11:5 17:19 44:3 294:5 378:1 confirm 64:18 65:14 confirmation 10:10 confirmatory 287:21 288:11 confirmed 26:11 327:15 confirms 58:8 conflict 3:17 4:19 4:21 5:3,9,20 6:6 6:7,10,12,16,20 6:22 7:9 8:15 conflicted 3:20,22 4:2,4,6,14 5:22 6:3 conflicts 4:17 5:13 7:13 confronted 290:16 confused 42:22 163:9 232:13 340:15 418:9 confusing 238:4 239:18 confusion 237:9 297:2 Congressional 8:17 connected 376:22 conscious 223:3 consequence 237:9 245:21 264:2 288:2 consequently	223:20 336:6 conservative 21:20 216:2 273:15 290:8 293:21 385:2,16 consider 75:3 106:19 111:2 122:21 126:5 132:8 145:19 267:16,19 298:20 299:13 301:16 323:15 335:17 350:15 considerable 264:2 293:19 384:11 consideration 61:10 considered 59:6 70:22 232:12 234:14 252:2 253:19 318:20 327:4 354:15 Considering 313:11 consist 149:18 consistency 231:19 367:6 consistent 26:13 229:12 232:5 consistently 29:3 157:12 158:4 389:20 consolidate 43:5 constant 272:1 399:19 402:8 constitute 225:2 constituted 223:11 230:18 constitutes 258:12 construct 210:19 construction 56:12 208:21 209:8,14 309:10 constructive 345:13 consultant 2:6 6:6 consulted 322:3	consuming 190:20 contact 317:18,19 318:9 319:3,5 contain 264:20 336:18,18 339:2 347:17 361:4 374:5 382:8 392:13 411:17 contained 13:18 283:18 325:1 336:16 337:13 347:6,7,8 359:19 367:5 371:3,11 containers 245:8 containment 335:17 contains 164:11 218:19 253:8 256:9 265:7 309:2 316:18 367:18 contaminant 253:20 255:15 263:8 271:11 279:7 contaminants 223:5 225:6 234:5 243:11 254:11 256:10 262:18 268:3 275:10 281:21 292:12 contaminated 286:15 contamination 10:14 245:5 268:7 content 330:22 337:16 contention 384:16 contents 14:16 313:5 context 196:21 387:3 404:1 contingent 391:18 continue 132:3 153:3 324:9 407:22 414:22 415:10 418:10 continued 245:13	323:21 continuous 273:19 289:1 355:10 374:14 contractor 2:10 8:14 contractors 7:3,6 contradicted 227:6 351:1 contradicts 344:8 contrary 356:7 contrast 365:2 contribute 295:8 contributed 261:8 contributing 349:6 contributors 215:15 control 1:5 261:4,4 controlled 251:19 252:15 261:15 controlling 368:7 controls 60:9,9 368:2 controversy 161:1 convened 1:15 327:1 conversation 118:2 195:20 204:7 230:22 conversations 304:6 conversion 130:13 130:21 convert 245:16 converted 370:18 convince 21:8 31:2 32:15 44:22 242:22 283:15 290:11 convinced 281:15 282:19 290:6 convincing 241:22 copied 384:14 copies 10:20 11:17 12:1,6,11,11 copy 42:10 45:21 46:5,10 136:22	137:4 139:22 149:3,15,22 150:19 153:8 180:15 184:17,19 185:11,14 214:15 214:16 217:22 308:22 309:1 312:22 316:1 411:11 copying 205:16 cordoned 60:10 core 197:14 323:12 corner 63:2 64:21 corollary 360:1 correct 26:8 29:8 38:4 49:2 51:18 65:10 126:22 133:4 135:3 139:13 144:18 153:3,17 166:18 174:11 175:2 186:7 215:20 232:16 234:7 253:11 289:6 292:5 302:3 350:21 353:15 356:20,20 392:17 393:14 395:5 397:3 404:7 405:12 407:15 411:15 corrected 227:10 229:6 230:17 234:17 257:3,19 265:12 correcting 25:14 correction 260:20 309:13 corrections 309:12 corrective 316:14 corrects 258:8 correlate 97:14 correlation 99:8 corresponding 80:1 cost 142:9 143:20 count 145:12 193:1
--	---	---	--	--

322:19	26:12 28:13 30:13	critique 305:4	19:12,13,13 22:7	164:19,22 165:15
counted 223:15	30:21,22 32:9	418:12,17	24:12,19,21 25:3	166:1,1,4,4,6,9
counting 192:4	33:19 35:22 36:4	CRL 239:12	25:11,16,19 27:1	169:14 170:18
358:20 359:3	37:6,7,8 39:15,20	cross 111:17 407:9	27:5,12,20 28:7	174:10 175:5,14
couple 8:20 30:10	42:2 43:15 44:17	crosses 28:4,5	29:6,14,17,20,20	175:17 176:8,19
84:3 145:9 151:12	44:19,21 45:1	77:11,12	29:22 30:1,12,18	177:10,13 178:19
214:3 216:14	52:16,17 53:16,22	cross-section 139:5	31:11 33:4,8,14	179:5,21 180:5,14
221:18 222:2	54:9,19 55:2	crucial 296:19	34:3,21 35:2,10	181:3,6 182:8,21
223:1 225:18	61:21 62:18 63:21	crude 160:13 161:7	36:1,2,12,21 37:9	182:22 183:6,18
226:4 232:2	65:8 66:10,16	cubic 318:7 320:14	37:9 38:10,13,15	183:18 184:20
247:15 266:21	67:3 70:12 71:16	328:11 365:15	39:14 40:1 41:4,5	185:16,18 186:10
268:22 280:3	74:2,12 75:1,9	cull 188:8	41:7,16,19 42:4	193:7 194:10
298:19 304:12	76:2 78:13,18	cumbersome 90:12	43:14 44:5,22	196:22 197:1,7,7
307:8 309:8	80:2 81:2,12 82:2	cumulative 286:11	46:7,10,11 49:5	198:19 204:4
315:16 316:11	82:7 85:4,12 86:5	286:20 287:2	49:20 50:2,4,8,11	214:10 218:19
322:3 338:10	87:15 90:1 93:8	curie 330:22	50:20 53:19 55:8	222:4,4,5 224:11
362:21 408:6	93:12,17 106:7,8	curies 305:3 307:17	55:13 62:19 63:11	241:18 242:7,13
coupled 325:21	106:14 107:5	307:22 308:7	63:18 66:5 68:6,6	242:14,16,19
course 13:21 25:22	112:14,15 113:4	313:8,14 324:4,13	69:18 70:18 75:3	246:19 249:8,8,13
44:13 50:16 81:22	120:10 121:11,18	326:4 329:6	75:10 77:4,14	249:15 251:18
94:12 167:2 197:4	131:13,13,21	338:21 339:1	78:13 80:18,19	252:18 253:13
221:4 243:10	132:11 135:16	357:3,3	82:6,10,15 83:9	255:3,3,12 256:6
245:8 263:6	136:9,13,13 149:9	curious 383:20	83:13 84:8,9,21	258:17 259:3,8
288:17 295:3	150:4,5,10 157:1	current 100:7	87:12 88:17 89:15	260:21 263:16
307:2,12 310:9	co-authors 313:21	117:3 125:21	89:16 90:18 92:4	266:10,15,20
322:18 328:4	co-worker 215:9	145:11 338:20	94:17 95:10,11,16	267:2 269:3,19
369:12 391:18	221:22 231:7,8	339:5	95:18 96:17,21	270:8,13 271:16
COURT 385:17	361:10 386:7,20	currently 252:10	97:3 98:4 99:5,20	271:22 272:2,11
cover 15:8 16:5	399:18	curve 53:10	102:16 105:13	272:12 274:9
208:11 216:18	crack 325:10	cut 88:8 130:1	109:17 110:2,3,6	276:15 281:4
274:17 305:18	cracks 336:10	cuts 147:2	110:20 111:21	282:19,21,21
306:21 342:17	345:9,19,20	cutting 371:1	113:12,14,17,22	283:14,17 285:5,7
358:13	create 55:12		114:2 117:20	285:22 286:6,14
covered 125:2	364:19	D	119:9 121:1,5	286:17 287:7
145:20 172:20	created 94:15	D 3:1	122:8,18 123:5	297:13 298:17
244:3 245:4	333:9	daily 226:21	124:8,10,18	299:1,16,17,20
246:22 247:16	creating 302:7	230:16 306:3	128:13 131:13	300:3,5,7,22
251:9 262:11	391:21	336:2 358:17	132:5,9,11,22,22	301:11 302:7,11
361:17	credible 272:16	363:2,17 392:20	137:1,3 138:19	306:4,5,5,10
covering 146:4	273:17 329:11	395:13,16 396:13	139:8 144:15	312:1,2,6,8 314:3
covers 265:6	criteria 140:20	397:4,16	145:1,1,4 149:7	320:22 321:22
316:16 320:10	150:8,9 202:3	damage 101:14,19	149:12,16,18	328:1,7,21 329:3
336:13	211:10 214:4	101:22	150:11,12 152:1	329:11 330:1
coworker 16:7 17:2	223:4,10	dark 376:6	153:18 154:6	332:8 333:1
17:2,10,12,22	critical 272:18	dash 410:20 411:17	155:11,11 157:12	344:13 347:13
18:21 19:2,6,8	criticism 160:17	data 16:13,14,16	159:1,11 161:12	348:19,20 358:17
22:4,6,21 24:12	criticized 172:3	16:17 17:5,6,9	161:15 163:15	359:1,17,19 360:4

360:8,18,21 361:1 361:5,6,9,11,17 361:19 362:5,13 362:18 363:5 364:13 366:15 367:14,18 369:18 372:4,15 375:1 376:11,13,20 377:1,20 378:11 380:13,16,20,22 381:1 382:1,6,11 383:12 384:6,20 384:20,22 386:8,9 387:22 390:5,14 390:18,19,22 391:4,11,15,17,19 391:20,21 392:3,4 392:8,10,13,15,19 392:19 393:4,7,7 394:20 395:6,8,11 396:19,20 397:6 397:12,14,22 398:1,20 399:3,6 399:18 402:11,20 402:21 403:2,18 405:14 408:3 409:3 410:7,9,14 410:20,22 411:4,6 411:8,16,17 412:9 412:11 413:5,8,13 414:4 415:8,15,16 416:10 418:3 420:19,20	databases 43:6 dataset 16:12 19:12 25:17 108:1,13 data's 413:20 date 15:12 39:1 42:14 131:9 170:3 203:15 216:7,10 226:5 239:12 282:9 284:21 285:12 307:1 309:21 317:21 411:22 dated 16:4 47:1 149:1 150:20 215:1 216:11 304:21 305:4 410:21 dates 309:8 316:6,8 317:12,16 daughter 315:3 daughters 315:14 318:22 320:4 340:4,5,9 354:17 day 20:12 21:2 24:14 25:5 52:13 64:12 77:19 78:6 101:6 105:21 131:1 158:13 181:15 190:15 193:5 210:15 216:14 313:14 363:15 394:14 days 90:5 223:17 255:13 268:7 279:3,6 338:10 380:1 394:12,14 day-in 272:1 day-out 272:1 de 355:15 deal 3:11 27:6 181:18 221:18 250:7 287:17 314:8 321:16 348:13 388:10 dealing 155:10 180:6 259:13 deals 303:6	dealt 243:10,12,14 247:5 251:18 254:5 debate 231:3 debating 200:3 decade 146:7 decades 146:12 263:22 decay 331:5 335:20 decayed 331:18 decide 47:18 148:2 148:6 160:22 260:4 273:17 296:15 351:9 decided 16:19 39:13 244:11 261:20 277:10 360:3,5 361:20 405:15 decimal 67:17 decision 223:2,4 259:10 387:15 decisions 259:7 272:10 declared 5:22 6:3 decommissioning 127:5 decon 250:20 decontamination 130:6 decreasing 318:10 deemed 385:15 deep 330:5 default 21:21 22:10 24:5,6 78:5 79:5 197:3,5,17,20 221:22 268:17 292:11 348:3 351:18 defaulted 268:9 defaulting 254:6 defects 309:10 Defense 143:21 defensible 274:10 deficiency 182:6,15 183:14 deficit 325:20	341:13 define 200:6 257:12 337:7 defined 233:1,6 308:8 363:11 defines 317:2 defining 230:13 255:14 definitely 107:20 161:6 334:1 definition 32:5 33:3 95:8 229:6 230:18 232:5 233:15 258:12 definitional 233:11 definitive 257:21 degree 233:21 313:6 341:18 357:8 degrees 167:3 deja 39:16 393:9 deliberately 404:9 deliberates 84:4 delineate 108:16 deliver 103:15 302:22 delivering 359:13 delta 325:10 demonstrate 274:5 demonstrated 99:3 185:8 241:17 413:12 demonstrates 49:18 274:2 demonstration 403:18 denominator 69:3 denotes 410:3 Department 1:3 94:18 143:21 dependent 103:16 158:10 depending 106:15 depends 103:2,3 106:17 112:18 275:20 depicts 320:19	depleted 228:1 depletion 335:19 336:5 depth 310:22 derbies 370:20 derivation 252:17 derivatives 364:20 derived 249:16 250:3 264:17 308:10 325:14 358:17 describe 18:20 19:2 159:10 172:22 213:1 336:14 386:21 described 35:5 83:4 174:9,13 206:9 251:17 335:15 368:16 401:3 describes 412:5 describing 79:12 359:20 414:5 description 305:21 367:12,16 368:1 369:9,21 386:12 400:18 401:4,15 descriptions 368:15 369:7 371:10 387:9,20 descriptors 181:9 design 47:1,11,13 80:3 187:3 Designated 1:23 3:7 designed 16:11 43:21 44:11 71:14 257:11 320:13 desired 149:12 despite 389:9 detail 22:3,19 25:18 102:11 135:14 198:13 205:12 221:11 265:7,8 330:9 338:13 358:13 401:2 402:19
--	--	--	---	--

403:14 419:3	285:22 286:2,2	direct 169:18	discussion 40:19	337:16,21 338:21
detailed 178:11	347:11 384:18	240:22 249:10	46:9 60:17 86:7	339:6 350:15
182:7 186:18	different 16:13,20	315:4	147:13 160:16	386:19
368:1	28:15 35:5 40:21	directed 279:17	197:21 214:8	documentation
details 133:12	43:3 49:20,21	direction 73:18	279:10 296:22	256:1 299:7,10
145:16 203:1	61:22 62:2,18,19	74:15,17 160:4	333:3 359:5,12	documented 225:9
324:9	63:21 72:9 76:1,1	398:22	384:11 388:15	255:12
detection 104:1,3,6	79:2 87:15 108:11	directly 253:12	389:17 392:2	documents 99:12
104:7,15	108:12 127:5	279:17 316:2	discussions 367:21	240:16 266:11
detector 348:20	141:1 147:2	344:7 356:19	DISEASE 1:5	283:20 322:3
determination	161:15 163:16	disagree 92:21	disequilibrium	352:19
106:12 155:13	164:4 166:21	141:18 305:7	310:16 323:11,14	DoD 143:12,19
223:11	167:3 168:8 177:1	352:2	323:20	144:12
determine 20:2	184:14,22 185:6	disagreeing 249:3	disk 411:22	DOE 2:12 7:7,13
47:3 54:8 100:1	186:21 189:7	disagrees 305:5	disparity 263:13	16:3 132:13
110:14 175:17	195:3 197:21	discern 242:3	disposed 248:10	192:19 222:2,15
195:4,5 302:7,11	198:1 202:17	disclosed 267:4	distribute 10:21	223:2,21 224:11
329:9 351:8	226:3 252:6 267:9	disconnect 9:3	358:1	227:6,16 229:5,21
determined 25:7	270:2 274:20	disconnected 8:12	distributed 13:8	230:8 233:18
166:3 223:6	279:14 282:22,22	40:12	295:14 385:6	236:2 238:20
277:19 356:1	292:9,9 298:1	disconnects 98:19	distributing 13:7	239:2 240:1,2
determining 225:5	300:5 312:7 323:1	discover 360:20	distribution 20:10	242:14,17 249:8
361:11	361:6,22 363:13	368:5	23:6,22 25:7	253:8 257:2,3
develop 17:13,17	363:19 365:10	discovered 409:22	26:10 28:3 29:22	269:14 283:7,18
114:14 124:11	367:7 368:14	discrepancies	30:2,5 82:4 85:22	301:16 307:3
137:11 139:13	369:8 370:5	222:17 224:2,21	86:11,13 87:17	392:13
141:8 325:7	372:21 375:18,21	224:22 226:3	109:4 130:17	doing 17:19 36:11
developed 18:3,4	377:11 381:12	263:19 270:1	217:7 243:20	55:22 70:3 72:2
19:3 131:14	386:22 387:20	discrepancy 226:11	249:16 269:16	89:9 97:15 117:10
149:14 220:3	390:2 394:12	233:15 262:21	391:4 400:10,12	123:16,16 128:22
292:12,13 300:16	401:21,22 410:6,6	discuss 9:10 13:1	401:18 402:9	145:8 158:11
329:21 336:21	414:19	13:17 15:3 18:15	distributions 20:17	162:8 163:13
developing 96:19	differentials 336:2	32:17,19 33:2	401:22	175:12 184:13
132:10	differently 107:17	61:6 78:19 102:6	distrust 270:11	190:10 194:6
deviation 20:13	difficult 97:5	102:7,10 115:14	disturbed 313:5	195:10 207:7
25:21 28:1 29:16	115:21 209:3	121:10 154:20	disturbing 364:21	242:11 283:6
58:10	258:20 347:17	198:12 220:16	divide 364:4	354:2 378:19
Dexterity 61:17	diffusion 244:13	221:14 376:11,15	divulge 13:22	394:10 408:11
diagnosis 39:1	245:15,22 246:5	discussed 21:10	doc 174:3	DOL 7:7
89:16	253:22 266:7	46:8 61:11 89:18	document 16:2	dollar 142:19,19
difference 179:1	284:19 289:13	117:3 133:9	133:19 134:22	dollars 144:2
180:1 194:3 250:1	313:22 324:22	135:16 152:15	135:20 136:4	dome 310:6 316:15
276:3 312:6	325:4,9 329:21	220:17 352:22	148:22 151:3	318:9 319:21
313:12 325:3	330:5 334:15	399:13 419:3	152:20 165:4	320:17 328:2
327:12	347:10	discussing 9:22	254:10 255:1,18	333:7 335:8
differences 72:18	dilution 252:10	101:17 117:5	271:14 296:19	336:10 339:22
222:10 225:2	diminishing 188:3	161:8 295:19,20	306:1 307:2	340:13,18 341:4

341:16 342:3,6,8 345:4 domes 309:15 314:21 315:5,19 320:7,8 door 176:17 dosage 349:15 dose 19:10,22 20:18 30:6,15 33:20 37:17 38:6 38:16 41:8,12 53:20,21 54:20 82:8,18 84:5 89:12 91:10,12,13 91:19 93:16 94:15 103:11,15 109:1 123:1 126:2 129:22 156:20 168:11,20 175:12 175:15,18 176:11 177:18,21 178:9 182:3,5,12,19 185:19 186:4,13 186:22 192:1,15 193:20 194:10,10 197:13 210:1,2,3 210:3 214:14 215:10 225:4 226:14 259:17 267:7,10 271:7,20 272:7 294:7,12,22 295:9 301:17 302:9,12 310:5,7 315:12 316:18 317:6 319:20,22 320:16 321:1,7 326:17,21 327:2,6 328:2,15,18 329:16 332:13 335:9 339:21,22 340:10,18 341:2,3 342:3,5,13 346:2 346:3 348:15 349:16 351:5,17 352:16 355:3,7,11 359:21 361:12 362:13 377:5,6	414:6 doses 17:3,3,20 42:11 64:1,2 80:18 81:16,16,17 85:4 102:19 122:20 210:9 215:3 226:8 274:11 294:4 326:9 327:10 348:22 350:12 351:10 356:22 359:1,2 371:13 378:1 399:16 403:22 dosimeter 187:8 dosimetrically 275:14,18 dosimetry 16:7 197:7 dots 360:14 doubled 244:20 doubt 53:7 73:2 377:4 downloaded 256:18 390:19 398:3,5 dozen 212:12 Dr 4:14 5:19 6:15 6:18 7:12 10:9,13 11:18,22 12:4,12 12:19 13:2,10,12 13:13,19 14:3,6 14:17,20 15:16,22 23:1,14,18 24:2 25:10,13 29:5,8 31:8,14,17,21 32:2,7,21 34:7,11 35:20 36:14 37:4 37:5,8,10 38:2 39:8 42:13,16 43:4,10,19 45:18 45:20 46:2 47:15 48:1,6,8,11,14,18 49:2,3,7,12,16 51:9,12,16 52:1,4 52:10,14,15 53:9 53:13 55:3,5,6,9	56:5,10,19 59:1 59:14,16,18,19 60:1,4,8,21 61:18 64:2,3,5,6,8,10,11 64:12,16 65:2,12 65:19 67:11,14,19 67:21 68:2,4,5,10 68:15,18 69:1,4,6 69:11,14,20 70:1 70:4,6,14,20 71:1 71:18 72:1,20 73:2,13 74:19 75:12,16,19 77:7 77:8 79:3,6,7,16 81:5,7,8,10 83:15 83:17 84:2 85:1,2 85:7,16 87:2,3,5,7 87:9,19 88:6,8,16 92:11 93:10 94:4 95:5 96:1,5,8,14 97:4,20,22 98:2,7 98:9 99:13,16 100:14,18,21 101:9,11,16 102:13 103:2,22 104:12,13 105:17 106:1,4,9 107:19 108:3,7,14 109:20 110:10 111:8 114:8,10 120:18 120:21 121:9,14 121:15,16,18 122:4,5 123:12 124:2 128:4,10 129:6,14,19 130:7 130:13,15,16,19 131:8,14,21 133:4 135:9 136:21 137:13,22 138:21 139:4,12 140:11 140:18 141:11,15 142:14,21 143:3,8 144:16 146:18 147:19,21 148:4,9 148:16 154:1,4,8 154:11,16 155:1 157:11,21 158:14	160:3,9,12 161:13 162:7,17,22 163:3 163:6,8 164:1,3 166:13,17 167:2,8 167:14,18 168:11 168:18,22 169:5,6 169:7,10,17,22 170:2,3,9,13,16 171:5,10,15 172:7 172:15,19 173:2,4 173:5,7,11,18,22 174:6 176:12 177:8,16,20 178:21 179:16 180:2,16 181:10 182:2,9,10,14,19 183:10 184:7,11 184:13,21 185:1,3 185:4 186:7 187:4 187:7,12 188:1,16 189:16 190:9 191:20 192:1,12 193:14 194:4,11 194:15 195:17 196:17 198:16 199:4,6 200:9,9 200:19 202:1,5,14 202:18,21 203:2,5 203:8,13,21 204:5 205:19 206:4,8,15 207:8 211:3 214:22 216:9,11 216:16,21 217:10 217:13,18 218:2,5 218:9 219:20 220:2,7,10 221:1 221:16 222:21 225:19 230:21 232:1,18 233:10 234:7,15,17 238:2 238:7,14 240:21 242:11 243:2,6 246:6,9,16,22 247:2,4,9 248:18 249:2 250:21 251:3,11 252:1,16 252:19,21 253:11	253:15 254:3 257:20 258:3,14 258:21 259:12,16 260:2,4,12,19 261:16,21 264:6 268:11,21 269:11 270:4 272:19 273:13 274:4,14 275:14,17 276:1 279:8,18 282:4,17 283:21 284:14 288:19 289:2,3,8 289:17 290:10,15 291:4,6,13,15 292:15,17,20 293:2,12,20,22 294:16 295:3,6,11 295:13,15 296:9 296:18 298:2,5 302:22 303:10 304:14 305:15 306:17,19 307:7 312:13,17 324:19 326:11 327:13,14 327:21 329:12 330:21 331:7 332:22 333:21 334:4,8,10,11,14 334:19 339:18 340:15,20 341:5 341:10,12,14 342:2,15,21 343:1 343:2,7,15,17,19 343:21 344:1,3,19 345:2 346:5,12 347:1,4,8,9 349:8 349:12 350:21 351:11,15 352:3,9 353:21 354:6 355:22 356:17 357:5,6 371:14 373:12,17,20 374:2 404:2,8,16 404:19 405:22 406:8,11,15,21 407:4,8,16,21 408:17,22 409:11
--	--	--	--	---

409:15 413:22 414:9,18 415:3 416:3 draft 16:5,10 164:9 384:13 draw 76:9 181:4 214:9 250:19 drawing 45:5 56:2 67:5 drill 145:2 drive 133:16 134:16,22 146:21 151:15,20,22 152:6 153:10,20 359:18 360:19 408:2 driven 336:2 driver 295:12 drop 186:3 210:5 343:10 dropped 166:10 328:18 dropping 43:16 drum 229:10 DS 277:19 due 107:9 215:15 313:12 335:20 duplicated 152:6 duration 100:6 241:10 379:7 durations 90:4 dust 364:22 DWE 306:3 359:19 360:12,16,20 363:1,1 364:1,12 365:6,12 366:20 367:15,17 368:16 368:19 369:15 371:4,19 372:17 374:6,8 375:4 376:1,22 381:8 382:8,15 383:5 385:13 389:12 390:4 391:17 392:14,15,19 394:14 395:8,10 395:21 396:15,19	396:20,21,22 398:1 399:3 400:17 401:5,14 403:10 410:6,9,19 410:21 411:12,14 411:16 412:3 415:19 416:1 DWEs 368:17 382:9 383:5 391:22 <hr/> E <hr/> E 3:1,1 earlier 37:2,3 80:11 112:1 180:19 184:15 251:17 276:8 312:2,9 328:15 368:17 earliest 254:20 279:6 early 96:18 187:9 196:5 208:11 223:17 232:12 255:12,13 256:2 262:17 266:5,10 268:7 279:3 297:3 299:1 308:13 349:7 earth-shaking 71:19 easier 372:18 383:15 416:13 easily 165:7 337:9 easy 88:21 128:1 143:4,4 economic 248:9 editorial 147:12 effect 47:16 79:13 150:4 221:22 295:20 333:4,9 336:3 345:21 effective 339:8 effectively 28:2 296:17 efficiency 93:13 110:7 318:15 320:11	efficient 33:13 83:16,18 108:2 211:5,8 276:8 efficiently 128:22 346:1 effluent 287:7 effort 43:5 123:17 141:9 160:20 162:18 163:5,6 172:22 223:21 236:2 266:16 370:4 380:5 408:9 408:15 409:7 eight 21:13 26:18 27:8 38:14 51:19 89:20 150:1 186:11 210:15 227:14 235:5 314:9 318:4 363:16,16 367:8 393:12 394:9 406:9 417:10 eighties 212:13 245:1 254:13,16 254:17 eight-hour 394:4 either 62:16 98:1 106:13 134:20 135:10,11 153:20 159:14 294:5 308:22 312:22 373:7 407:19 elaborate 105:1 163:14 electronic 11:19 45:10,22 46:3 149:21 153:7 192:18 element 71:6 197:14 elements 236:22 eliminate 43:18 129:17 eliminated 150:3 eluent 281:2 email 217:1 218:14 253:16	emanation 330:6 341:6 embedded 21:22 embeded 280:1 emerged 269:1 359:15 emerges 57:7 Emily 2:11 7:4 10:16 13:3 14:6 emission 99:10 emissions 305:1 307:16 309:18 emphasize 313:17 emphasized 385:12 empirical 328:7 344:13 emplacement 322:2 323:15,21 324:6 331:12 employed 365:19 368:8 369:2 employees 7:3,6 56:14 112:8 126:3 150:5 employment 90:4 130:3 390:16 enclosed 311:8 ended 39:22 125:12 323:16,18 332:5 379:4 ends 263:9 Energy 94:19 enforce 283:8 enhanced 333:6 enlightening 369:22 enormous 50:2 360:2 enriched 21:3,5,14 224:16 227:22 246:3 247:22 248:2,8,9 251:1 enrichment 22:14 197:9 216:1 ensure 175:5 entail 378:15 enter 88:21 343:11	entered 110:20 175:5,6 entering 332:20 enters 332:12 entire 11:3 14:5 21:18 99:6 100:6 111:1 229:13 241:10,14 270:7 273:6 323:21 363:17 365:17 366:7 367:17 382:9 383:6 404:11 entombment 329:19 entry 392:19 environment 106:16 321:14 332:21 335:4,16 336:1 341:20 349:1 environmental 106:15 348:8,10 349:19,21 envision 19:9 EPN 365:14 equal 104:6 equation 344:9 equations 337:12 equilibrium 311:11 311:14,18 321:18 321:21 322:17 341:20 equipment 288:4,5 378:14 379:9 equivalent 143:20 174:15 320:10 346:2 era 362:15 error 258:8 265:10 325:1 errors 147:8,10 escape 165:10 escaped 321:11 332:3,4,17 333:11 especially 57:19 254:16 262:17
--	---	---	--	---

294:14,16	eventually 34:21	392:15 410:20	existed 323:14,20	271:2 272:1 306:4
essence 320:6	34:22 160:16	412:6	exists 108:11	315:5,19 318:19
331:16 355:13	everybody 3:18	excellent 330:10	270:14 407:12	318:21 320:21
essentially 37:9	8:20 9:15 10:6	exception 30:13	410:3	354:14,16 358:17
39:2 112:11	14:10 42:20 58:6	244:5 312:2	exotic 104:19	360:22 361:5,14
165:14 166:1	60:6 198:13	362:14	expand 232:6	363:2,3,17 364:7
232:9 290:5	199:13 230:9	exceptions 241:20	expect 71:22 72:20	364:15 368:12
319:22 320:3,10	280:13 302:17	excerpt 24:11	74:9 81:3 94:6	369:7 371:9 373:5
320:15 322:16,17	evidence 35:16	excess 319:16	107:4 120:3	386:4 387:1 388:2
323:10 328:16	84:16 85:12	324:4,17	124:17 172:12	392:21 395:14,16
332:15,18 333:22	231:14 260:7	excessive 359:17	201:15 280:5	396:14 397:5
339:4 340:1,12,21	325:22	exchange 226:9	expected 204:14,18	401:16
345:22 355:4	evolved 131:20	exclude 287:4	313:11 342:11	exposures 17:22
357:12 358:7	exact 327:4 358:7	315:21	expeditiously	19:15 33:18 53:3
373:3	exactly 36:14 54:1	excluded 286:21	198:21	58:20 59:4 67:1
establish 288:16	55:3 60:1 87:19	excreted 24:14	experience 167:15	84:14 85:21 86:14
established 137:12	98:7 104:8 122:4	100:22 102:22	320:1	99:10 271:10
170:20 251:21	130:11 197:8	excreting 100:3	experimental	306:7 315:7 368:7
estimate 100:9,10	198:7 213:1 214:5	101:5	201:16	385:15,20 387:9
294:6 308:3,7	234:1 306:1	excretion 24:13	expert 6:8 327:15	expressed 314:7
324:16 326:8	337:20 343:4	25:5 26:11,14	explain 116:20	365:12
385:8	348:16,17 352:9	64:3,5,11 65:3,7	305:10 310:2	expression 65:3
estimated 307:17	376:4 382:18	65:15,17 66:8,10	318:2 333:4	extend 231:22
324:14	388:9 401:4	66:14 67:2 70:10	339:19,20 357:19	233:19
estimates 196:7	examination 161:3	73:6 75:6,11 76:5	358:3,9 386:3	extending 223:22
estimating 323:9	173:3	77:19 78:3,5,14	explained 144:14	extensive 46:16
et 63:14 130:5	examined 150:1	78:18 79:1,4,20	186:17 200:15	160:6 233:22
249:17 285:18	153:9	101:1,8,15 102:2	206:20 224:22	266:14 359:5
316:16	example 20:3 38:2	102:4 112:7	269:2	392:2
evaluate 16:11	38:3 39:4 48:7,20	excursions 291:5	explains 318:5	extent 47:19
112:14 115:4	64:20 73:5 75:4	excuse 12:19 136:9	333:5	110:14 137:9,19
129:20 209:3	77:5 91:1 98:2	195:15 206:16	exposed 35:15 88:1	184:8 191:21
350:11	103:7 105:6	272:7 333:13	215:3 242:2	exterior 314:20
evaluated 60:15	107:12 143:12	executive 149:5	246:12,14 271:12	315:9
125:21 174:21,22	144:16 159:15	152:15 153:6	273:10,12 287:19	external 41:12
334:9	179:9 204:20	exercise 82:21	290:4,12 327:11	169:15 186:4
evaluating 16:6	241:13 244:3	138:6 142:19,19	350:13	196:8 271:2
165:11	248:15 267:13,17	188:21 287:22	exposes 273:18	externals 159:21
evaluation 92:13	271:11 272:5	288:10,11 301:16	exposure 18:3 29:4	extra 12:1 85:19
115:16 174:10	300:6,22 388:12	301:17,18,19	30:16 35:18 36:6	extract 393:1
307:13 360:22	389:2	exercises 74:4	39:1 41:11 45:17	extracted 149:7
361:5 368:12	examples 84:10	exhausted 279:10	53:4 77:22 85:6	231:17 235:9
369:7 373:6 382:6	181:13	exhaustive 245:3	94:19 96:20 100:6	275:5 278:5 397:4
382:11	exceed 272:16,16	Exhibit 315:21	100:10,20 105:9	extraction 261:14
evaluations 157:10	exceeded 75:8	319:3 320:18	108:17,20 109:3	277:7 278:5
evaluation's 356:4	Excel 133:18	344:11	114:14,15 126:1	extraordinary
event 107:21	151:12 164:20,22	exist 62:9	168:3 180:20	252:9

extreme 269:7	387:7	241:17 273:16	268:18 272:9	78:14 81:12 83:8
eye 72:4 326:18,19	facto 355:15	274:12 285:17	273:9,18 284:11	84:5 87:11 90:17
F	factor 54:21 66:18	301:20 378:2	288:20 298:1	92:21 94:9 109:17
F 19:21 243:14	76:7,12,13,13	February 305:5	304:1 308:9	110:1,17 111:21
253:10 255:2	79:22,22 80:15	324:21	312:19 326:17	112:18 120:21
300:15	82:8 290:8 326:10	federal 1:23 3:7 7:2	327:6 329:16	121:2,6 124:16,17
fabrication 257:8	336:15 338:18	7:6	357:16 410:21	124:21 133:1
257:15	356:21 357:4	feed 149:9 246:9	fernaldhis20draf...	134:7,9,13 140:3
face 26:3	factored 393:22	264:7 278:15	151:4	151:17 159:4
faces 132:12	factors 81:18	284:7 289:1,13	Fernald's 228:10	179:15 189:18
facilities 132:14	188:12 197:16	feel 17:19 27:1	fewer 167:19	238:10 239:22
208:19 232:7	345:1	66:21 137:19	375:15	247:18 256:18
361:22 370:5	facts 106:19	138:2 154:17	field 238:18,21	258:7 262:5
375:10 376:14	factual 56:1 67:6	270:12 280:15	239:4 253:10	270:15 297:20
378:13 381:13	fail 258:4,14	288:3 294:4	262:3,10,12	338:7 352:20
405:15	fair 32:11,20	329:10 338:16	299:16 300:14	382:20 398:18,20
facility 29:15	162:18 233:21	371:5 409:12	fifties 275:1	415:9
189:15 360:15	301:12	feeling 212:3	figure 93:19 140:14	finding 109:14
363:5 365:5	fairly 71:7 201:16	feels 403:5	357:2 394:22	176:8 217:12
367:12,16,17	201:20 207:18	feet 318:7 320:14	fil 182:22	222:3 238:17
381:14 382:10,12	247:15 249:22	328:11	file 41:6 70:18	249:15 287:18
397:18 400:14,15	280:9 346:1	felt 157:7 241:21	150:17,22 151:3,8	307:10,11 308:1
400:22 401:6,15	377:22	376:12 397:12	173:6,7 183:2,17	findings 183:5
402:3	faith 283:11	Fernald 1:10 3:4	183:17,19 214:11	220:4 221:17
fact 18:16 21:9	faithfully 46:11,16	3:22 4:15 5:22	214:13 410:20	226:4
23:7 24:15 26:13	137:3,5	6:4,6 7:22 9:16	412:5	fine 15:22 144:9
33:12 36:9 49:3	fall 30:5 94:10	16:7 34:1 37:15	files 45:12 148:21	152:8 213:2 221:6
56:21 62:9 65:14	121:3	37:20 47:4 86:22	149:22 150:1,3,7	297:11 419:8
95:14 112:9	falls 245:19,20	91:9 94:13 118:18	150:8,13 151:11	finger 61:14,15
116:20 134:16	familiar 8:22	149:10 152:20	152:16 153:2,7,9	finish 22:18 41:3
146:8 158:2	262:14 351:20	168:1,12 169:12	153:11 156:18	75:16 118:2,6
175:17 177:13	far 39:18 51:16	169:20,22 170:5	157:2 159:8 164:5	327:22 409:6
188:18 221:12	95:20 167:22	175:13 178:16	166:7 171:4,6,12	418:19
222:16 225:14	185:15 267:1	186:15 187:9	171:16 192:18	finished 17:18
226:20 233:14	316:22 330:11	189:9 192:15	411:8 418:7	118:8 329:2
236:10 243:19	340:10 382:5,22	193:18 195:22	fill 36:5 37:2,2	fire 190:8
252:3,14 260:5	390:9 419:21	196:2,22 199:20	filled 200:20 325:8	firm 140:15
261:6 263:6	farther 227:7	215:4 222:12	fills 138:6	first 7:3 18:20 19:1
278:19 287:16	382:20	223:13 224:10	film 183:18 191:15	19:18,19 25:15
297:18 308:6	fashion 96:10	226:10 227:18	207:5	28:6,18 30:7,9
315:13 316:12	97:15 208:4	228:4,5,7,16,20	filter 287:7	39:1 63:4 64:22
325:21 326:18	311:21	229:8 230:3,20	final 202:4,9	113:7 116:13
328:9,14 331:11	fate 283:7	231:15 233:3	finally 211:14	146:19 182:20
340:16 341:20	Faust 2:5 5:12,12	236:18 243:5	320:7 368:3,10	195:22 204:21
342:9,10 355:1	favor 385:9	244:15,18 255:21	370:11	214:2 218:20,22
356:3 380:13	favorable 32:9	262:7,22 265:1	find 10:7 28:13	221:18 223:8
	54:10 71:17	267:1 268:4,13,13	32:5 34:6 62:15	226:4 242:5 252:4

254:4,9 257:10	344:18	foresee 39:6	406:7 416:17	122:3
260:4 261:20	flows 257:13 337:2	forget 189:13 282:8	417:19	F-1 243:14 247:18
271:9 275:7 296:3	339:11	327:4	fourth 317:17	
304:4 316:8	fluoride 248:4,7,11	forgot 165:10	four-page 24:11	G
317:16 326:6	251:1 370:10	forgotten 104:8	fraction 29:19	G 3:1
358:9,14 359:15	flurry 379:21	350:8	36:10 40:1 42:12	gamma 237:17
359:18 360:13	flush 413:4	form 137:5 217:2	162:19 273:8	279:4 281:22
361:15 369:2	FMC 315:18	248:2 278:6	290:1 378:17	282:10,14
372:19 376:20	FMPC 149:3 150:5	329:11	frame 116:14	Gantt 176:13
391:22 398:2,4	150:19 152:21	formal 115:12	211:18	gaps 107:6 108:5
414:19	284:10 411:10,14	135:19 136:4	frames 146:4	159:14 160:2
fiscal 228:5,8	focus 129:3 131:19	220:14,18,21	framework 74:7	203:19 336:12
fission 22:9 275:7	169:18 257:14	231:16 305:22	frankly 140:5	345:19 403:3,15
276:7 280:22	299:12 361:21	formalize 174:13	252:12 253:1,19	405:21
281:20 282:1	focused 257:7	formalized 177:5	270:14 344:12	gas 320:11 389:20
286:3,8,10 292:2	foil 333:8	formally 296:8	free 154:17	gaseous 244:13
292:3,12 293:1,9	fold 387:14	303:3	frequency 47:5,7,9	245:15,22 246:4
293:10	folder 149:1 152:19	format 135:19	204:18,22	253:22 266:7
fit 37:3 269:15	396:21,22	former 7:17,22	frequently 59:11	284:19 289:13
fits 391:4	folks 50:16 58:8	formerly 314:21	181:1	gaskets 309:17
Fitzgerald 2:7 6:9	63:7 127:14	forth 10:1 14:12	front 13:4 51:13	gathered 232:10
6:9	146:20 192:17	116:12 131:12	205:8 230:11	gee 115:19 122:17
five 3:9 13:9 39:3,4	193:15 303:21	200:4 224:4	249:21	general 6:7 17:8
50:4 81:5,8,19	305:3	225:15 228:16	fuel 236:22 257:15	18:15 36:1 47:3
84:19 140:3 150:8	follow 52:2 119:8	297:4 316:21,21	fulfilled 114:22	241:18 303:7
169:3 196:6	119:15,21,22	374:21 383:2	115:5	306:5 363:7 365:1
218:20 227:3	120:2 178:11	forties 232:12	full 28:2 82:4 86:10	365:4,7 373:11
248:4 253:2,21	179:21 193:7	forward 36:13	87:16 109:4	374:11 375:8
269:4 311:22	194:7 293:13	156:13 176:14,20	130:17 196:7	384:9,18 386:15
312:14 329:5	300:11	190:1 202:9 403:8	fully 55:17 123:17	389:10,19 391:1
350:5 375:12	followed 221:5	418:10	125:2 379:4	391:10
fixed 237:19 400:4	249:15	found 38:10 77:10	function 28:9 49:22	generalized 336:19
flag 88:7	following 313:4	77:18 125:1	functions 62:16	364:6 405:16
flagging 350:6	314:16 318:13	155:20 181:13	127:16	generally 21:15
flame 245:20	339:21 388:9	190:6 241:8	fundamental 54:3	210:15 241:19
263:21	follows 241:8	368:12,18 376:8	270:11	generated 299:7,8
Flats 39:19 43:8	follow-up 112:13	foundation 26:20	Fundamentally	302:10 331:5
155:7,10,15,20	297:14	four 10:17,21 11:1	336:5	generating 232:22
159:6,11,19 160:4	footer 216:17 307:1	12:21 13:3 24:8	funded 329:14	233:4 266:1
163:13 171:19	force 273:9 336:9	27:12 50:15 54:21	furnace 364:17	generation 240:10
172:8 181:13	forced 366:1	57:5,5,10 81:18	370:20	277:8,15 278:4,11
189:12 190:4	foregoing 40:6	99:4,5 157:14	further 39:10 72:7	278:21
flip 352:19	118:13	158:5 173:21	314:5 320:16	generic 301:6,7
floor 210:11 345:4	foreman 209:22,22	202:16 311:21	350:11 355:2	geometric 20:12
flow 240:10 260:21	210:4	312:13 370:17	Furthermore 89:13	25:21
302:1 318:6,13	foremen 210:9,9,11	372:15 376:18	315:15 327:8	getting 26:22 71:1
335:10 337:9	210:14	390:13,13 397:10	future 15:12 96:19	71:2 116:8 122:11

154:5 156:22	77:16 78:16 80:5	61:1 67:22 113:6	210:13,17 212:21	214:20 238:2
169:19 170:17	80:7,10,10,13	132:5 156:6 157:4	214:13,21 215:17	240:13 247:8
188:15 198:7	83:8,20 84:5,19	157:16 245:21	216:3 218:10	252:22 259:9
220:13 251:5,13	90:12,19 92:9,16	250:11 318:12	219:8,22 231:5	268:17 273:14
259:4 270:17	93:1 95:17 96:8	337:11 370:9	234:8 242:5 254:7	278:20,22 279:6,9
271:19 333:14	97:9 107:10 108:4	393:8,9 401:15	260:5,8 265:16	279:20 281:15
335:3 352:22	109:7,16 111:20	going 3:13 9:21	270:19 271:5	325:22 333:19
359:10 393:14	112:19 114:14	10:2,18 11:10	273:3 276:20	371:7 380:2
394:9,9	119:2,6,14 127:4	12:20 15:7 20:22	288:16 294:12	403:19 404:11
give 19:22 34:11	132:19 136:11,22	21:4 22:2,18	296:11 297:16	417:3
37:15 48:3 63:8	139:20 140:15	25:18 26:16 28:10	302:21 303:15	gooseneck 309:16
71:9 73:20 86:22	148:7 157:22	30:6,17 31:2,3,21	304:7 305:18	316:15 319:19
87:16,17 97:18	162:2 163:19	32:7,12,14,18,19	306:5 308:15,17	336:11 345:20
103:10 109:3	171:12,16 179:6	32:22 37:5 42:1	310:12,12 312:20	goosenecks 320:9
131:8 133:13	185:13 186:4	47:20 53:18 54:1	314:19 315:15	gotten 48:10 60:21
198:17 199:4	187:6 191:5,13	54:2,6,6,8,11,15	324:9 330:16	72:19 387:7
206:21 242:19	192:16,22 194:12	55:9 61:1,5 62:12	344:2 346:21	Grab 80:17
249:11 281:21	196:3,10 200:7	65:12 71:5 72:16	347:13 350:3,7	grade 381:20
306:12 346:14,16	211:19 214:11,15	76:9 79:9 80:3,21	351:8,9 352:13,15	gradually 237:18
365:21 388:11	214:18,21 217:4	80:22 81:1 82:21	352:17 353:5,7,13	278:3
389:2	227:14 242:15	83:5 85:14,15,19	354:1 355:20,21	granted 70:2
given 26:8 28:22	244:9 256:7 257:1	88:11 91:21	358:10 364:16	granularity 27:2,6
29:15,15 34:12	258:16 259:11	102:18 103:9	366:3,3,4,11,18	29:13 63:5 180:17
47:13 62:17 75:3	263:16 270:12	105:7,12 106:7	367:11 369:10	366:9 377:21
76:11 83:21 84:17	276:1 281:9	107:1 109:9,9,11	370:13 371:8,17	402:21 403:14
86:2 100:16 124:3	282:18 283:14	112:19 113:1,2	372:9,12 374:19	410:22
223:10 230:22	296:1,5 299:17	116:21 118:7,10	378:21 380:3	graph 57:20 343:21
354:4	304:13 307:8	118:12 119:8,17	381:20 382:19	graphical 57:16
gives 78:17 133:19	308:2 310:20	119:21,21 120:1,3	383:21 384:1	graphically 269:20
180:4 305:6 307:1	312:4 314:5,9	120:14 123:22	386:21 398:19,20	graphs 57:15 61:2
311:11 368:15	318:1 319:2	126:16 128:5	403:8,19,22	grapple 128:18
giving 27:22 67:6	320:18 322:12,19	130:6,10 132:21	407:22 413:16,17	great 3:18 27:6
301:5,8 342:13	326:13 327:17	136:14,19 137:3	414:6 418:10	71:18 154:11
glad 389:3	330:1,12 334:19	137:10 140:16,19	419:8 420:15,17	169:10 191:4
glancing 146:1,14	346:17 354:22	141:5,10 154:12	good 3:3 22:21	207:8 221:3
go 9:4 11:1 13:16	357:22 366:21	155:3 156:15	23:14 32:2,16	287:17 302:15
19:16 20:4 22:18	380:11 381:11	161:18 166:8	36:14 37:11 69:5	386:20 387:19
24:4,7 25:11 27:9	382:19 383:21	171:1 172:4,6	75:17 78:16 84:15	greater 22:2 91:11
31:19 33:13,15	386:20 387:19	173:21 179:15	85:15 109:5 115:8	91:15 123:3 243:4
35:10 39:10,13	390:11 392:11,20	181:16 182:12	130:8,9,20 148:16	273:18 357:14
45:20 46:6 47:13	393:15 398:21	188:20 189:22	148:16 157:2	green 249:19
47:17 53:15,18	403:20 408:2,17	191:13 193:17,19	162:18 174:3	Griffon 1:20 3:21
55:14 56:20 57:20	409:5,9 411:7	193:21 194:16	187:14,20 188:2	3:21 34:8 39:9
58:11 61:7 63:6	414:7 415:5,6	198:9,17 200:5	188:13 189:17	41:2 42:15 43:7
63:10,12 69:17	goal 361:10	201:17 202:9	190:16,22 195:11	43:11 45:7,19
72:7,13 74:17	goes 3:18 22:10	203:18 204:12,20	195:12 199:6,18	46:1,18 59:21
75:17,20 76:19,20	24:22 25:2,3 26:3	209:14,16,19	200:11 202:3,3	88:10,17 89:1,4

90:9,17 91:2,6	203:4,6,12,17,22	46:22,22 55:10	348:16 382:14	Hanford 222:12
92:5,20 93:5,18	204:10,16 205:4,9	65:4,6 74:7 82:20	384:4 385:21	223:7 224:14
94:5 96:12 97:2	205:15,21 206:7	83:19 84:3 99:17	388:4,14 389:22	226:9 227:10,17
105:15,19 106:3,6	206:12 207:9,17	109:3 118:18	390:11 403:16	228:4,6,10,12,16
106:17,21 109:8	207:22 208:5,20	124:15 130:18	407:10 415:11	228:19,19 229:8
110:1,12 111:4,18	209:2,10,15	131:1 133:10	418:9	230:2,20 233:9
112:12 114:3,18	210:18 211:1,13	136:17 142:4	guidance 398:18	234:2 236:1 237:8
116:16 117:17	212:2,15,20 213:6	160:4,6 166:11	guideline 138:5	239:4 240:11
119:4,12,14 120:1	214:1,5,12 258:16	175:4 199:21	guidelines 13:21	254:20 255:18
120:6,20 121:21	258:19 260:11	215:6 250:22	293:13	257:7,13,14
123:7,19 124:13	262:2,9,13,20	273:7 283:14	gut 138:2	260:17 274:18
126:7,11,19 127:8	263:3,12 264:10	291:21 296:1	guy 53:12,18,19	275:1 276:15
127:21 128:5,16	284:1,15,20 285:1	305:19 308:2	82:5 88:4 98:16	281:7 283:19,20
129:2,11 130:22	285:4,7 297:6,12	351:12 359:6	109:2 122:17	hang 186:5 275:9
131:5 132:2 133:5	298:4,7,10 303:2	406:12 414:1,20	guys 131:12 137:11	hanging 190:21
134:4,10,13,19	346:20 348:9	419:4	243:15	220:21 418:22
135:4,11,21 136:5	350:2 351:4,13,19	grouped 69:17		Hans 2:8 6:15,17
136:11 138:18	352:6,10 374:3	221:17	H	12:20 13:6 102:8
141:17,22 142:5	392:6,22 393:3,6	groups 31:3 45:15	half 58:15,16 72:20	169:6,7 196:17
142:13,17 144:8	393:20 394:1,13	62:4,5,15 79:20	72:21 104:7	198:16 304:21
145:5,9,17 146:9	394:21 395:3,10	249:17	212:12 304:16	305:9,20 306:16
150:21 151:5,9,14	395:19,22 396:5	group's 74:15,16	339:8 363:16	306:16 307:6
151:18 152:4,7,17	396:11,16,20	growth 331:22	369:2,13 418:15	312:11 325:8
153:5,15,21 154:2	399:10,22 400:5,9	GSB 23:4,6,8,18,20	halfway 405:3	327:19 330:10,14
155:2 157:20	400:15,21 401:7	GSBs 23:5	half-life 331:15	335:1,14 337:18
158:15,19 159:1,5	401:12,17 402:5	GSD 79:5,8 384:21	half-lives 331:21	340:15 343:4
159:9,20 161:9,14	402:13,16 404:15	402:10,11	340:5	344:6 350:5 352:4
162:15 163:17	404:17 409:17	guarantee 84:4	hallways 365:3	353:15 356:19
164:6 165:6 166:8	411:1,5,9,14	guards 86:18	hand 13:14,20	Hans's 325:19
167:5,13,17	412:2,13,16	guess 65:15 68:20	271:10 291:8	326:14 327:18
169:20 170:6,11	414:10 415:2	90:9 95:7 96:1	321:2 340:19	330:6 334:9,13
170:14 171:3,8,18	416:7 418:18	112:21 119:4,6	389:15	338:17 350:22
172:9 173:8,13	419:5,13,18 420:2	129:2,9 138:16	handed 13:2	356:19
174:4,20 175:22	420:6,18 421:5	139:7,14 147:4	handle 107:17	happen 53:17 54:1
176:5,22 177:6	grinding 370:6	153:5 154:4,11	263:19 279:7	80:21 337:10
178:1,7 179:2	grip 301:22	156:4 157:21	325:18 371:8	happened 85:18
180:4 181:8,12	gross 150:2 237:15	178:5 182:1	378:4	160:10 179:5,13
182:17 183:4	237:17,17,19	195:18,20 196:20	handled 241:11	180:13 274:17,20
185:21 186:8	279:3,4 281:20,21	207:9 209:5	246:19 291:11	301:20 332:6,13
187:2,6,10,16	281:22 282:10,10	214:17,20 221:16	handling 177:11	happens 28:7 56:19
188:4 189:11,20	282:14 287:8	231:3,6 235:4	handout 415:19	60:18 190:8
190:14 191:10,17	365:19,20	246:6 263:13	handouts 306:12	192:16 259:16
192:6 193:11	ground 406:15	264:10 271:19	358:2	367:1
194:1,9,13 195:11	group 3:5,20,22 4:2	280:11,14 284:11	hands 420:15	happy 109:7
196:13 197:22	4:4,6 9:16 11:22	289:18 291:16	handwritten 46:5	162:12 388:12
199:1 201:22	28:8,11 29:2,14	298:10,11 303:2	163:1,3	hard 42:10 45:21
202:2,7,15,19,22	30:4 33:11 44:4	304:4 339:18	hand-count 92:16	46:5,10 107:13

116:11 136:22	292:15 306:18	364:15 367:3	95:22 96:4 111:12	174:1 273:3
137:4 139:22	394:14 398:12	373:2 385:9 386:4	132:11 133:3	345:19,19
149:3,15,22	heard 40:20 154:14	386:8,17 387:16	137:2 139:8 140:2	human 1:3 97:16
150:19 153:8	210:21 280:2,10	388:1,2 393:11,18	149:4,8,12 150:11	98:14
180:15 184:17,19	280:18 296:7	395:18 399:15	150:15,20 164:8,9	hundred 241:16
185:11,14 187:12	hearing 137:2	402:11 420:8	165:13,15 173:3	253:4 413:19
214:15,16 241:22	184:22 251:12	higher 18:2 23:17	173:13 175:5	hundreds 27:21
308:22 309:1	270:11 281:5	45:16 54:2 58:20	180:14 184:18	139:1
312:22	294:1 298:21	62:7 66:9,16 67:2	214:10 390:15	hypothetical 34:9
Harry 2:9 6:21 7:1	heart 26:17 358:21	67:3 70:11 71:22	HIS-20_B_bioass...	
65:10,17 67:14	362:9	72:21 73:7 76:8	164:11	<hr/> I <hr/>
68:10,11 95:6	heavier 336:5	76:13,14 78:7,22	hit 8:11 90:21	IB 239:6
113:11,13,15	heavily 12:4	79:14,21 80:1	223:14 232:22	ICRD 377:9
126:22 127:3	heavy 63:8 229:10	81:1,9,18,19 84:7	hits 147:7,11	ID 133:19 164:21
137:14,14 138:4	Hebron 1:16	85:21 109:3 110:4	hmm 73:5	Idaho 224:17
138:11 141:8,15	heck 87:16	112:1,7 180:20	Hoff 2:4 4:20,20	idea 48:19 71:10
143:5,5 154:4,8	held 303:8 386:6	242:2 248:6,13	hold 9:4,5 13:5	73:2 74:5 97:19
162:10 166:14	Hello 40:9 98:21	250:11,12 251:13	27:15 33:1 40:3,4	109:13 113:22
168:6 194:21,22	help 19:6 51:12	252:7 253:3 255:7	148:11 227:12	130:8 302:10
195:13 212:19	196:12 330:16	263:7 268:10	326:5 404:12	362:3,22 378:15
213:8,9 249:13	371:12 406:1	269:4 288:6,6	holding 283:4	381:6 382:4
250:5	helped 249:14	312:3 323:17	holds 33:6	identical 300:2
Harry's 212:5	helper 77:9 80:9	higher-end 29:3	hold-up 344:22	319:22 322:15
hat 186:5 275:9	helpful 73:18	highest 19:22 77:21	home 346:15	328:16 332:15
hate 67:17 143:4	108:10 124:1	84:14 87:22 245:4	honest 117:8	identified 2:1 79:18
haystack 33:10	126:17 165:17	247:17 254:6	honestly 117:1	102:1 107:5
hazard 294:21	194:14 406:11	286:14 321:7	326:11	164:14 216:4
HAZWOPER	helping 387:15	387:10,11	hopefully 10:19	244:6 257:3
127:15	heterogeneous	highlight 352:17	120:6 191:9,10	273:21 307:11
head 138:17 256:15	71:19 298:14	419:8 420:7	hoping 13:17	308:14 316:6
310:4,8 314:1	hexone 277:5 278:2	highlighted 311:7	242:13	329:9 362:10
315:11 319:17	hey 8:10 329:3	335:13 419:6	hoppers 284:10	369:15 374:1
320:4,13 321:13	HHS 2:11,12 7:4,6	highly 105:7	hour 206:18 304:16	381:8 409:10
326:2 328:10	7:8	264:15 385:2	316:6,19,20 317:8	identify 3:16 8:4
332:5,12,20	hidden 27:16,18	highs 394:7	317:10,20 319:7	12:21 33:14 52:7
333:10 335:1,3,16	high 17:21 35:14	high-end 30:5	319:11 320:21	73:17 111:10
335:19,20 336:7	52:20 71:7 76:12	high-level 228:13	321:4,8 328:13	119:8 194:18
337:5 338:2 341:1	77:13 78:1 79:14	high-side 377:5	342:4,12 343:13	329:8 403:10
341:8 343:11	84:6 99:10 100:13	historical 99:12	355:8,12	identifying 122:22
345:22 354:2	101:19 125:12	222:10 243:10	hours 173:1,21,21	123:4 176:18
355:6 408:16	170:15 189:9	256:1 307:8 309:4	174:5 194:15	317:16
heading 236:7	224:16 245:6,14	315:17	210:15 318:11	iffy 288:11
health 1:3,8 3:6	245:17 247:15	history 16:8 21:18	328:12 340:3,7	ignorance 353:9
4:17 40:11 104:18	274:8 287:4	35:13 93:19	354:22 363:17	imagine 107:13
118:17 199:20	289:12 294:10	114:15,15 209:7	house 297:22 345:6	170:7 187:11
304:1 365:19,20	317:8 342:13	HIS-20 27:10 41:18	Howell 2:11 7:4,4	285:9 298:8
hear 113:11 242:9	353:13 363:22	46:12 76:20 95:13	huge 96:20 105:12	immediately 224:2

immensely 127:20	incongruity 250:9	42:12 89:20 90:5	372:8	intelligent 169:1
impact 267:6 273:4	inconsequential	206:22 207:1	initially 109:15	intend 130:14
296:11,14 302:8	226:14	369:5	160:20 235:22	200:13
302:12	inconsistencies	individual's 70:18	257:18 258:10	intended 233:19
impede 344:17	155:21 221:18	95:1 272:2,10,11	324:14 409:4	236:10 398:8
impedes 335:10	222:6	348:2	initiated 224:5	intent 244:18 294:3
implement 31:1	incorporated	indoor 341:20	injected 237:12	315:10 383:10
47:16	299:19	infer 366:2	inner 293:4 343:3	intention 404:5
implemented 59:22	incorrect 292:20	inferred 362:2	input 289:18 385:3	intentional 181:16
60:2	increase 23:21	366:10	inputs 368:16	intents 215:18
implements 337:12	378:22	infiltration 345:10	inquiries 242:8	381:10
important 17:7,17	increases 384:20	inform 117:2	inserted 234:5	interest 3:17 4:17
22:16 23:3,11	increasing 384:22	198:22	252:10	interested 44:17,18
49:17 51:2 61:8	incredible 290:10	informal 204:7	inside 336:22 342:8	195:20 333:14
76:19 168:2 251:4	incumbent 121:10	information 23:16	345:16 354:5	interesting 40:19
260:10 313:2	incurred 105:9	24:18 27:11 38:17	386:18	112:4 115:21
316:12,16 317:10	indefinite 354:21	56:1 67:7 68:8	insights 397:22	209:19 210:13
362:7 365:16	indefinitely 340:22	72:2,12 82:2	insignificant 174:1	364:9 366:21
385:12	independently	83:21 94:20 96:20	installed 309:17	367:22 368:19
importantly 246:18	149:16 175:10	111:11,12 119:17	310:1	369:12 375:9
impossible 53:1	index 70:7	119:18 142:9	instance 23:19	394:6
impression 231:1,4	indicate 75:10	218:3 221:2,13	160:15 317:3	interfere 9:6
405:7	231:14 360:19	222:18 231:17	328:7 354:19	interior 314:16
imputed 79:8	indicated 246:11	238:4 259:10	instantly 339:15	interject 194:17
incapable 278:17	270:6 360:22	260:18 264:20	INSTITUTE 1:8	198:3
incident 52:18	408:10	271:8,10 285:21	institution 358:19	intermittent
53:11	indicates 227:2	322:1 324:11	instruct 207:16	108:19
inclination 76:10	231:18	328:6 347:21	instruction 47:13	internal 16:6 17:3
include 126:3	indication 70:8	358:7 365:21	instructive 171:2	19:10,15 30:16
139:1 269:7	287:8	371:5,6,11 377:17	intact 53:1	38:16 94:19
286:19 291:10	indications 71:13	378:12 380:3	intake 17:3 20:11	169:15 196:7
376:15 415:15	indicative 105:8	387:7,8,14 403:1	20:17 22:11 24:6	359:2
included 150:12	222:14	406:18 408:1	24:7 26:5 36:6	internally 189:3
252:17 287:6	indicator 70:1,13	410:20 414:12	39:5 52:8 64:5	interpret 105:11
324:12 366:22	77:20	informative 26:22	65:14 81:15 90:1	271:21
367:13 369:9	indirect 325:18	83:13	101:3,4 105:2,4	interrupt 269:10
378:8 391:13	individual 26:1	informed 387:6	105:12 165:19,20	interviewed 229:18
407:19	27:2 31:20 41:22	ingested 21:2	267:12 271:17	inter-comparison
includes 192:19	45:11 75:2 94:21	272:17	272:3 385:3,8	165:22
215:10 385:4	97:3 106:19	ingestion 30:17	intakes 62:6,7 64:2	inter-site 299:8
including 274:8	128:13 155:10	inhalation 19:11	110:22 111:3	introduce 345:11
301:13 309:15	157:2 164:20	30:16 306:6	259:8 267:17,18	introduction 14:21
incompatible	171:4 183:6 185:7	inhale 103:3	270:22 298:18	367:10
344:10	185:16 195:8	inhaled 22:6	348:3 349:16,17	invalidate 397:15
incomplete 176:9	265:19 267:11	272:18	404:16	invalidated 288:7
incompleteness	373:7,9 374:7	initial 276:21	intellectual 353:7	invented 104:19
177:10	individuals 30:20	318:18 368:17	intellectually 356:8	inventories 86:17

inventory 233:2 244:20 261:4 326:2 330:18,19 342:7	346:8 349:19,21 350:22 351:7 352:1,5,7 356:2,2 356:18 357:5,6 358:22 359:10 370:1,13 382:3,4 384:12 385:22 390:8 408:13 420:14	47:10 49:21 62:2 62:16 74:5 76:21 76:22 77:3,3 79:19 83:9 84:21 85:1,9 89:14 90:3 90:6 92:22 94:10 95:1 97:10,12 108:17 111:10 114:15 115:8 116:10 117:10 119:17 122:6,19 125:2 127:2,3,11 138:7 139:9 157:3 160:14 161:3 162:14 167:12,19 167:21,22 168:3 180:21 184:6 188:5 191:16 193:12 201:1 202:17 204:13 282:18 360:22 361:5 363:4,12,13 364:8 367:16 368:11 369:6,7 371:10 373:5 382:6,11 386:11 387:9,20 393:15 393:16 394:4 396:1 399:15 400:11,18,21 401:4,15 413:2	128:2 130:8 133:6 135:8 136:17 153:22 161:11 169:5 180:18 194:16 195:15 198:4 199:4 200:5 200:7 206:16 214:20 216:8,13 216:22 219:18 222:19 225:12 231:13 242:9 243:8 251:22 253:15 259:11 269:9 270:5 281:17 304:11 305:11,12,16,16 306:8 308:10,13 313:20 314:12,15 316:4 324:14 325:16 328:7 329:2 333:22 334:3 346:6,13,14 366:12 379:2 403:13 410:1	324:7 J-19 315:20 316:3 J-28 314:11
invested 136:1	issued 17:1 59:20 115:11 220:19 257:2 305:4 308:10 316:4	116:10 117:10 119:17 122:6,19 125:2 127:2,3,11 138:7 139:9 157:3 160:14 161:3 162:14 167:12,19 167:21,22 168:3 180:21 184:6 188:5 191:16 193:12 201:1 202:17 204:13 282:18 360:22 361:5 363:4,12,13 364:8 367:16 368:11 369:6,7 371:10 373:5 382:6,11 386:11 387:9,20 393:15 393:16 394:4 396:1 399:15 400:11,18,21 401:4,15 413:2	194:16 195:15 198:4 199:4 200:5 200:7 206:16 214:20 216:8,13 216:22 219:18 222:19 225:12 231:13 242:9 243:8 251:22 253:15 259:11 269:9 270:5 281:17 304:11 305:11,12,16,16 306:8 308:10,13 313:20 314:12,15 316:4 324:14 325:16 328:7 329:2 333:22 334:3 346:6,13,14 366:12 379:2 403:13 410:1	<hr/> K <hr/>
investigate 115:4	issues 9:21 14:4 15:1 71:11 116:12 119:2 160:22 215:2 221:3 274:16 296:12,13 307:9 314:8 330:3 356:10 362:9,11 362:17 388:19	116:10 117:10 119:17 122:6,19 125:2 127:2,3,11 138:7 139:9 157:3 160:14 161:3 162:14 167:12,19 167:21,22 168:3 180:21 184:6 188:5 191:16 193:12 201:1 202:17 204:13 282:18 360:22 361:5 363:4,12,13 364:8 367:16 368:11 369:6,7 371:10 373:5 382:6,11 386:11 387:9,20 393:15 393:16 394:4 396:1 399:15 400:11,18,21 401:4,15 413:2	194:16 195:15 198:4 199:4 200:5 200:7 206:16 214:20 216:8,13 216:22 219:18 222:19 225:12 231:13 242:9 243:8 251:22 253:15 259:11 269:9 270:5 281:17 304:11 305:11,12,16,16 306:8 308:10,13 313:20 314:12,15 316:4 324:14 325:16 328:7 329:2 333:22 334:3 346:6,13,14 366:12 379:2 403:13 410:1	Kathy 2:10 168:13 168:14 169:7 195:16 196:21 198:16 206:4,17 210:21
investigation 121:8	item 154:12 155:2 228:8 355:20 360:11 361:8 362:19 372:9 373:16 386:2	116:10 117:10 119:17 122:6,19 125:2 127:2,3,11 138:7 139:9 157:3 160:14 161:3 162:14 167:12,19 167:21,22 168:3 180:21 184:6 188:5 191:16 193:12 201:1 202:17 204:13 282:18 360:22 361:5 363:4,12,13 364:8 367:16 368:11 369:6,7 371:10 373:5 382:6,11 386:11 387:9,20 393:15 393:16 394:4 396:1 399:15 400:11,18,21 401:4,15 413:2	194:16 195:15 198:4 199:4 200:5 200:7 206:16 214:20 216:8,13 216:22 219:18 222:19 225:12 231:13 242:9 243:8 251:22 253:15 259:11 269:9 270:5 281:17 304:11 305:11,12,16,16 306:8 308:10,13 313:20 314:12,15 316:4 324:14 325:16 328:7 329:2 333:22 334:3 346:6,13,14 366:12 379:2 403:13 410:1	Katz 1:23 3:3,6 4:7 4:12,22 5:4,7,10 5:14,17 6:1,13,17 7:1,5,10,14,20 8:1 8:7,13,19 12:14 12:18 40:3,9,9,17 98:21 99:15 118:9 118:16 138:11 194:18,22 195:13 199:9,18,19 303:14,21,22 380:11 398:9,14 421:6
investigations 306:13	iterated 223:6	116:10 117:10 119:17 122:6,19 125:2 127:2,3,11 138:7 139:9 157:3 160:14 161:3 162:14 167:12,19 167:21,22 168:3 180:21 184:6 188:5 191:16 193:12 201:1 202:17 204:13 282:18 360:22 361:5 363:4,12,13 364:8 367:16 368:11 369:6,7 371:10 373:5 382:6,11 386:11 387:9,20 393:15 393:16 394:4 396:1 399:15 400:11,18,21 401:4,15 413:2	194:16 195:15 198:4 199:4 200:5 200:7 206:16 214:20 216:8,13 216:22 219:18 222:19 225:12 231:13 242:9 243:8 251:22 253:15 259:11 269:9 270:5 281:17 304:11 305:11,12,16,16 306:8 308:10,13 313:20 314:12,15 316:4 324:14 325:16 328:7 329:2 333:22 334:3 346:6,13,14 366:12 379:2 403:13 410:1	keep 9:9 56:11 60:14 70:17 71:2 74:19 79:4 112:7 128:12 141:18 172:1 212:21 267:8 269:12 294:19 309:9 311:5 340:21 346:18 352:11 358:11 385:18
involved 159:10 162:11 315:7 328:3 359:17 367:7 378:21	items 15:4 132:3 218:1 359:7,12,16 362:8,9 373:6,10 382:6 383:1 386:1 386:2	116:10 117:10 119:17 122:6,19 125:2 127:2,3,11 138:7 139:9 157:3 160:14 161:3 162:14 167:12,19 167:21,22 168:3 180:21 184:6 188:5 191:16 193:12 201:1 202:17 204:13 282:18 360:22 361:5 363:4,12,13 364:8 367:16 368:11 369:6,7 371:10 373:5 382:6,11 386:11 387:9,20 393:15 393:16 394:4 396:1 399:15 400:11,18,21 401:4,15 413:2	194:16 195:15 198:4 199:4 200:5 200:7 206:16 214:20 216:8,13 216:22 219:18 222:19 225:12 231:13 242:9 243:8 251:22 253:15 259:11 269:9 270:5 281:17 304:11 305:11,12,16,16 306:8 308:10,13 313:20 314:12,15 316:4 324:14 325:16 328:7 329:2 333:22 334:3 346:6,13,14 366:12 379:2 403:13 410:1	keeping 115:8 351:13
involves 316:7 328:21	J	116:10 117:10 119:17 122:6,19 125:2 127:2,3,11 138:7 139:9 157:3 160:14 161:3 162:14 167:12,19 167:21,22 168:3 180:21 184:6 188:5 191:16 193:12 201:1 202:17 204:13 282:18 360:22 361:5 363:4,12,13 364:8 367:16 368:11 369:6,7 371:10 373:5 382:6,11 386:11 387:9,20 393:15 393:16 394:4 396:1 399:15 400:11,18,21 401:4,15 413:2	194:16 195:15 198:4 199:4 200:5 200:7 206:16 214:20 216:8,13 216:22 219:18 222:19 225:12 231:13 242:9 243:8 251:22 253:15 259:11 269:9 270:5 281:17 304:11 305:11,12,16,16 306:8 308:10,13 313:20 314:12,15 316:4 324:14 325:16 328:7 329:2 333:22 334:3 346:6,13,14 366:12 379:2 403:13 410:1	Kentucky 1:16
in-depth 196:10 364:11	Jennifer 2:4 4:20	116:10 117:10 119:17 122:6,19 125:2 127:2,3,11 138:7 139:9 157:3 160:14 161:3 162:14 167:12,19 167:21,22 168:3 180:21 184:6 188:5 191:16 193:12 201:1 202:17 204:13 282:18 360:22 361:5 363:4,12,13 364:8 367:16 368:11 369:6,7 371:10 373:5 382:6,11 386:11 387:9,20 393:15 393:16 394:4 396:1 399:15 400:11,18,21 401:4,15 413:2	194:16 195:15 198:4 199:4 200:5 200:7 206:16 214:20 216:8,13 216:22 219:18 222:19 225:12 231:13 242:9 243:8 251:22 253:15 259:11 269:9 270:5 281:17 304:11 305:11,12,16,16 306:8 308:10,13 313:20 314:12,15 316:4 324:14 325:16 328:7 329:2 333:22 334:3 346:6,13,14 366:12 379:2 403:13 410:1	kept 326:12
In-tank 277:3	Jim 2:2 4:14 19:4 48:15 94:7 99:18 102:21 109:18,20 182:2 190:3 215:20 232:1,16 236:14 260:16 263:14 333:19	116:10 117:10 119:17 122:6,19 125:2 127:2,3,11 138:7 139:9 157:3 160:14 161:3 162:14 167:12,19 167:21,22 168:3 180:21 184:6 188:5 191:16 193:12 201:1 202:17 204:13 282:18 360:22 361:5 363:4,12,13 364:8 367:16 368:11 369:6,7 371:10 373:5 382:6,11 386:11 387:9,20 393:15 393:16 394:4 396:1 399:15 400:11,18,21 401:4,15 413:2	194:16 195:15 198:4 199:4 200:5 200:7 206:16 214:20 216:8,13 216:22 219:18 222:19 225:12 231:13 242:9 243:8 251:22 253:15 259:11 269:9 270:5 281:17 304:11 305:11,12,16,16 306:8 308:10,13 313:20 314:12,15 316:4 324:14 325:16 328:7 329:2 333:22 334:3 346:6,13,14 366:12 379:2 403:13 410:1	kerosene 277:17
ionized 341:18	Jim's 41:9 92:21 118:21	116:10 117:10 119:17 122:6,19 125:2 127:2,3,11 138:7 139:9 157:3 160:14 161:3 162:14 167:12,19 167:21,22 168:3 180:21 184:6 188:5 191:16 193:12 201:1 202:17 204:13 282:18 360:22 361:5 363:4,12,13 364:8 367:16 368:11 369:6,7 371:10 373:5 382:6,11 386:11 387:9,20 393:15 393:16 394:4 396:1 399:15 400:11,18,21 401:4,15 413:2	194:16 195:15 198:4 199:4 200:5 200:7 206:16 214:20 216:8,13 216:22 219:18 222:19 225:12 231:13 242:9 243:8 251:22 253:15 259:11 269:9 270:5 281:17 304:11 305:11,12,16,16 306:8 308:10,13 313:20 314:12,15 316:4 324:14 325:16 328:7 329:2 333:22 334:3 346:6,13,14 366:12 379:2 403:13 410:1	key 10:16 11:5 22:3 275:8,13 310:15
irradiate 103:8	job 28:9 38:9,13,18	116:10 117:10 119:17 122:6,19 125:2 127:2,3,11 138:7 139:9 157:3 160:14 161:3 162:14 167:12,19 167:21,22 168:3 180:21 184:6 188:5 191:16 193:12 201:1 202:17 204:13 282:18 360:22 361:5 363:4,12,13 364:8 367:16 368:11 369:6,7 371:10 373:5 382:6,11 386:11 387:9,20 393:15 393:16 394:4 396:1 399:15 400:11,18,21 401:4,15 413:2	194:16 195:15 198:4 199:4 200:5 200:7 206:16 214:20 216:8,13 216:22 219:18 222:19 225:12 231:13 242:9 243:8 251:22 253:15 259:11 269:9 270:5 281:17 304:11 305:11,12,16,16 306:8 308:10,13 313:20 314:12,15 316:4 324:14 325:16 328:7 329:2 333:22 334:3 346:6,13,14 366:12 379:2 403:13 410:1	kidney 103:13,15
irradiated 232:15		116:10 117:10 119:17 122:6,19 125:2 127:2,3,11 138:7 139:9 157:3 160:14 161:3 162:14 167:12,19 167:21,22 168:3 180:21 184:6 188:5 191:16 193:12 201:1 202:17 204:13 282:18 360:22 361:5 363:4,12,13 364:8 367:16 368:11 369:6,7 371:10 373:5 382:6,11 386:11 387:9,20 393:15 393:16 394:4 396:1 399:15 400:11,18,21 401:4,15 413:2	194:16 195:15 198:4 199:4 200:5 200:7 206:16 214:20 216:8,13 216:22 219:18 222:19 225:12 231:13 242:9 243:8 251:22 253:15 259:11 269:9 270:5 281:17 304:11 305:11,12,16,16 306:8 308:10,13 313:20 314:12,15 316:4 324:14 325:16 328:7 329:2 333:22 334:3 346:6,13,14 366:12 379:2 403:13 410:1	kind 14:11 23:21 31:1 71:12 73:22 74:11 83:1,3,9 93:1 98:14 100:8 114:2 121:17 129:10 130:12
irrelevant 272:22 273:2		116:10 117:10 119:17 122:6,19 125:2 127:2,3,11 138:7 139:9 157:3 160:14 161:3 162:14 167:12,19 167:21,22 168:3 180:21 184:6 188:5 191:16 193:12 201:1 202:17 204:13 282:18 360:22 361:5 363:4,12,13 364:8 367:16 368:11 369:6,7 371:10 373:5 382:6,11 386:11 387:9,20 393:15 393:16 394:4 396:1 399:15 400:11,18,21 401:4,15 413:2	194:16 195:15 198:4 199:4 200:5 200:7 206:16 214:20 216:8,13 216:22 219:18 222:19 225:12 231:13 242:9 243:8 251:22 253:15 259:11 269:9 270:5 281:17 304:11 305:11,12,16,16 306:8 308:10,13 313:20 314:12,15 316:4 324:14 325:16 328:7 329:2 333:22 334:3 346:6,13,14 366:12 379:2 403:13 410:1	
Isaf 2:12 7:12		116:10 117:10 119:17 122:6,19 125:2 127:2,3,11 138:7 139:9 157:3 160:14 161:3 162:14 167:12,19 167:21,22 168:3 180:21 184:6 188:5 191:16 193:12 201:1 202:17 204:13 282:18 360:22 361:5 363:4,12,13 364:8 367:16 368:11 369:6,7 371:10 373:5 382:6,11 386:11 387:9,20 393:15 393:16 394:4 396:1 399:15 400:11,18,21 401:4,15 413:2	194:16 195:15 198:4 199:4 200:5 200:7 206:16 214:20 216:8,13 216:22 219:18 222:19 225:12 231:13 242:9 243:8 251:22 253:15 259:11 269:9 270:5 281:17 304:11 305:11,12,16,16 306:8 308:10,13 313:20 314:12,15 316:4 324:14 325:16 328:7 329:2 333:22 334:3 346:6,13,14 366:12 379:2 403:13 410:1	
isotopes 282:2,16 293:4		116:10 117:10 119:17 122:6,19 125:2 127:2,3,11 138:7 139:9 157:3 160:14 161:3 162:14 167:12,19 167:21,22 168:3 180:21 184:6 188:5 191:16 193:12 201:1 202:17 204:13 282:18 360:22 361:5 363:4,12,13 364:8 367:16 368:11 369:6,7 371:10 373:5 382:6,11 386:11 387:9,20 393:15 393:16 394:4 396:1 399:15 400:11,18,21 401:4,15 413:2	194:16 195:15 198:4 199:4 200:5 200:7 206:16 214:20 216:8,13 216:22 219:18 222:19 225:12 231:13 242:9 243:8 251:22 253:15 259:11 269:9 270:5 281:17 304:11 305:11,12,16,16 306:8 308:10,13 313:20 314:12,15 316:4 324:14 325:16 328:7 329:2 333:22 334:3 346:6,13,14 366:12 379:2 403:13 410:1	
isotopic 365:22		116:10 117:10 119:17 122:6,19 125:2 127:2,3,11 138:7 139:9 157:3 160:14 161:3 162:14 167:12		

138:4 139:5,18 140:14 141:3 174:14 188:14 198:5,6,9,10 200:16 246:2 285:21 287:21 292:21 295:19 299:10 338:13 351:22 352:22 362:4 364:5 367:10 369:11 372:3 375:8 376:19 378:4 379:18 381:5 382:3 383:20 385:21 389:13,18 396:9 399:4 414:10 418:9 kinds 72:9 226:3 285:14 330:7 352:18 kinetics 313:22 knee-jerk 198:6 knew 234:1 309:11 401:4 know 3:9 15:13 20:15 22:4 26:15 28:19 29:1,17 32:5,18 37:15,19 37:22 39:20 40:4 41:3,6,13,15,16 41:17,21 42:1 43:13,17 44:16 49:3 52:21 54:1 54:10 55:10,19 60:1,18 61:22 62:1 66:5,12 69:8 71:4,6 73:22 75:21 76:11,16 77:20 78:4,17 81:17 83:4,5 85:14,18 86:1 87:14,21 88:18 91:1 92:13 93:22 94:8,22,22 95:4,7 95:15,20 98:2,14 99:1,6 101:1,13	101:13,14 102:1 104:4,11,22 105:4 105:12 109:18 110:4,21 111:8,16 112:2,21,22 113:9 113:20,21 114:11 114:13,16 115:3,6 115:20,21 116:21 117:4,7,18,22 119:15 120:13 121:8,17 122:15 123:5,10,15,22 124:1,15,19,20,22 125:6,11 126:5,10 126:13,16,18 127:15,17 128:22 130:4,4 132:6,14 132:18,22 133:2,7 133:9,9,14 134:20 135:6,15 136:22 139:15 140:5,15 140:21 141:3,9,14 141:20 142:12,15 143:5 144:20 145:4,6,7,16 146:2,3,12 148:18 152:5 154:13 156:2,7,9,11 157:1,8,16,18,19 158:2,4 159:22 161:10,20,21,22 162:1,2,3,5,6 163:11,19 165:11 166:11 167:15 168:13,14,16,19 168:22 169:3,3,11 170:3,4,8,22 171:14 172:5 173:17 175:10 178:5,8,14,18,19 179:8,13,14,20 180:6,13 181:12 181:15,20,21 182:10,14 183:2,4 183:6 184:6,7 185:15 186:9,10 186:14 187:1,22	188:5,10,10,10,15 190:5,6,16,18,18 190:22 191:2 192:16 193:16 194:8 195:19 198:15 201:13,14 201:17,19 202:3 202:12 203:22 204:4 205:7 206:2 208:7,12 211:6,17 212:3,20 220:13 220:20 221:9 225:7,21 233:8 236:11 239:16 253:4,20 254:13 254:16 258:21 263:16 267:9,21 268:1 269:21 270:14,18 271:3,3 271:5,9 272:5,16 272:22 273:6,12 275:2 279:11 280:5 281:20,22 282:17 283:7 285:10,13 286:18 288:14 289:10,18 290:22 291:16 294:2 295:7,19,21 298:4,15,15 299:2 299:20 300:4 301:20 305:11 312:5 325:3 329:3 333:16 334:16 337:11 338:6 339:14 340:14 341:6 344:3 346:12,15 347:13 347:16 348:15,17 353:3,4 357:11,13 357:14 366:15 368:13 370:3,5 371:14 374:14 375:15 378:6,18 378:19 386:14 387:4 389:9,10 392:4,10 395:14 397:1 398:10	399:2,4 400:20 403:19,20 405:22 409:9 417:11 420:7 knowing 195:21 321:22 knowledge 85:17 113:3 366:1,10 knowledgeable 229:17 known 149:14 252:14 263:7 291:5 301:9 knows 14:10 267:2 K-65 10:1 306:21 309:5 315:19 329:19 349:2,20 350:18 353:18	<hr/> L <hr/> label 113:18 254:21 labile 280:6 labor 378:20 labor-intensive 378:5 lack 161:3 386:9 lag 98:14 laid 408:1 landscape 306:9 language 45:3 257:21 258:7 large 3:11 33:18 39:7 47:18 50:1 50:14,15,18 81:14 89:17 93:15 123:17 126:16 163:21 164:4 166:5 172:21 185:10 187:19 188:17 222:17 242:18 249:22 266:16 273:3 300:1 313:6,11 341:16 349:15 384:6 385:13 389:17 391:15 Largely 272:9	larger 37:19 late 3:10 11:19 50:13 latency 38:21 39:5 89:17 latest 359:19 Laughter 67:16 109:22 143:2 144:3 Laurie 12:16 lax 97:16 layer 337:4 laying 414:12 lead 65:11 72:13 73:17 Lead-210 310:17 311:8,9 322:13,16 323:4 331:14,15 331:19 leak 336:14,15 leap 339:20 learned 163:12 379:2 409:19,22 leave 51:1 62:12 103:14 190:20 212:19 291:20 352:14 397:10 409:16 421:1,4 led 222:18 left 15:9 53:1 200:2 265:22 276:11 304:17 310:20 321:2 326:3 332:10 337:15,21 352:20 left-hand 63:2 64:21 legacy 42:21 43:6 legally 21:19 legitimate 237:9 legitimately 126:13 lengths 386:21 387:19 lengthy 121:17 240:16 Leo 2:5 5:12 lesser 102:3
--	--	--	---	--	--

lessons 163:12	lifetime 81:16	243:17	location 348:6,7	140:22 142:7,7
let's 16:1 19:9 20:2	lifting 63:8	listen 27:19 61:20	locations 242:1	144:11 145:19
24:4 26:2,4,17	light 73:22 232:3	62:14 115:22	374:16,18	146:7,20 147:15
34:2 35:7 36:16	291:16 297:2	344:4	locker 365:4	148:9 152:10
36:22 37:13 38:20	345:3 346:11	listening 206:17	374:20	155:15 156:4
53:15 55:12,16	356:3 375:22	listing 120:4	LOEL 224:20	160:14 161:7
59:11 61:4,7,18	376:10 399:5	lit 282:1	225:7	168:2,13 169:16
65:21 80:6,10,13	likes 84:11	litany 325:11	log 134:5 269:16,16	171:7,13,16,16
80:17 81:10,13,16	limit 104:1,3,7,7,15	liter 50:21 52:22	logbook 133:19	175:22 176:1
83:8,9 97:7	168:4 321:20,20	140:1 164:15	logbooks 133:2	181:22 188:6,13
110:10 118:1	limitation 127:2	197:15	137:4 145:13	190:7 191:14
120:21 121:4	limitations 55:20	literally 266:11	151:15 152:11	192:3,7 195:4
122:21 139:16	limited 17:6 366:8	270:18	163:1,1,4	196:10 200:13
140:3 143:14	limiting 91:16	literature 102:15	logic 55:4 123:13	202:10,20 206:9
146:19 157:22	160:20	241:5 322:4	logical 122:16	209:7 210:13
183:12 186:3,3	limits 248:10 371:9	little 10:2 16:8,20	220:16 414:16	218:21 227:14,19
191:7 192:13	line 4:8,10,22 5:15	20:22 25:18 34:19	logistical 3:10	228:5 229:21
193:10 199:11	6:13 7:5 8:2,9,21	35:17 42:22 45:8	logs 134:5 152:13	238:6,7 241:10
220:10 221:4,6	40:4,11,13,14	63:5,9 81:1,2	log-normal 25:7	242:13,22 248:22
241:15 259:12	42:19 51:10 57:21	88:12 104:22	391:2	249:18 253:13
260:4 281:9 317:4	57:22 58:2 63:7	113:5 120:19	long 9:16 14:12	268:1,5 270:13
319:2 322:19	65:13 111:9	127:11 129:15	26:3 40:14 47:20	274:3,17 283:1
331:16 346:17	121:20,22 154:9	163:9,13 177:1	100:22 102:22	286:5,7,17 297:8
375:22 376:17	166:15 168:15	198:11,12,18	103:10 124:6	297:12 299:15,22
389:8 397:9	181:5 213:9,10	200:20 204:7	136:3 145:15	300:13 303:3
411:12 415:6	214:14 219:7,7	205:18 224:15,15	163:21 172:5	305:16 306:3,10
level 44:8 69:15	249:14 257:10	232:6 245:13	194:6 212:10,22	308:22 309:13
77:13 180:17	259:4,7 267:5	250:8 252:7 262:3	294:10 343:15,18	310:17 311:6,16
225:7 245:4,6,14	270:5 273:22	286:10 295:8	366:5 367:9 380:7	319:3,14 324:11
254:1,6 255:7	303:17 304:22	297:13 310:3	longer 282:1	327:18,19 329:1,7
263:7,8 271:13	306:16 337:14	326:16 332:15	328:18	330:2,13 338:12
289:12 293:21	358:4,6 368:15,15	353:1 359:5	long-term 285:18	343:7,19,20 344:4
294:21 311:1,18	373:6,16 376:22	360:14 372:18	look 10:18 15:21	346:6,11 348:18
312:9 318:8	377:22 378:7	376:16 377:8	18:20 25:1 33:13	356:8 358:14
323:13 346:1	379:1 382:6	385:11 392:7	34:5,9 35:11,21	360:5 372:6,8,10
353:7 371:13	397:19 409:14	401:16 406:1	38:18,20 41:18	390:13 394:6
375:6 388:1	lines 139:5 163:11	lived 345:7	42:16,22 43:10	408:20 409:7
403:13	180:18 227:21	liver 103:13	50:11 57:17 62:3	410:5,7 415:19
levels 99:11 101:16	linked 292:4,7	lives 339:8	63:17 78:11,12	418:6
102:3 243:11	lion's 375:1	Lloyd 2:12 7:8,8,11	80:15 84:19 85:8	looked 21:7 27:11
246:15 248:13	liquid 277:1	load 404:5	86:4 90:3,6,13	38:4,9,12 41:6,22
253:20 256:1	liquid-liquid 277:6	loaded 415:8	92:22 95:2 96:9	60:6 89:14,16
268:8 279:7	list 15:7 94:10	loan 98:16	97:9 110:5,13	127:1 133:21
280:22 287:9	180:20 215:14	locate 148:21	111:6 116:4	134:21 146:6
293:6 340:1 365:4	217:7 256:8	361:19	119:16 120:8	147:2 159:13,21
life 81:17 290:13	381:12	located 150:15	124:16 133:12	159:22 160:13
300:6	listed 98:12 121:4	315:18 390:15	134:1,3 138:15,19	178:16 182:5

196:1,1 241:4 243:15 249:6,12 253:18 255:2 263:17 266:20 275:19 282:21 308:16 322:22 326:15 329:1,3 330:9 355:22 402:7 looking 10:16 25:20 27:19 33:9 33:16,21 34:22 39:22 41:4 46:20 50:3 55:14 62:13 63:1,4 77:22 89:19 90:22 91:2 107:22 111:5 116:6 121:13 123:8,11 129:10 133:15 138:19 152:18,20 154:6 154:13,18 157:1 158:21 159:14 163:14 167:15,20 170:22 177:12 178:10 181:19 182:18 185:7 186:2 188:12 192:10 195:2,8 210:7 219:9 221:21 235:3 239:14 241:1 247:14 281:8 298:20 300:4 306:9 311:1,2 344:10 350:7 354:19 361:16,21 364:10,12 389:11 389:16 392:8 406:1 410:8 416:10 looks 27:5 32:15 34:19 58:13 66:22 73:5 76:4 129:15 145:12 146:14 148:12 158:12 178:18 192:4	204:1,2 222:9 282:20 283:3,15 338:9 364:13 372:13 390:4 391:14 396:2,10 418:13 look-up 19:8 20:6 20:14 24:6 lose 15:10 96:21 351:20 420:9 losing 358:12 lost 40:4,5,11,14 41:16 88:2 107:16 163:20 179:22 353:1 lot 17:9 27:4 28:15 40:18,20 50:20 56:12,14 57:14 61:3 72:11,12 76:22 83:15,17 84:15 85:18 106:8 115:22 116:6 133:1 145:21 146:14 147:1,2 156:17 168:11 175:13 206:10 208:8,22 210:10 220:14 255:3 279:14 299:17 300:15 306:9 314:2 328:6 341:15 356:9 364:21,21 376:13 380:3,5 391:10 409:22 lots 97:20 285:21 325:8 372:4 loud 200:18 low 38:21 78:1 79:9 99:10 189:10 210:10 273:11 317:7 341:7 342:6 365:2 386:4 387:16 389:21 393:11 395:18 399:15 lower 72:22 75:5,7	75:10 81:2 181:2 265:22 266:5 321:2,20 339:4 353:6,7 lows 394:7 ludicrous 290:5 lunch 169:9 198:4 198:12 199:8,10 199:22 200:3,10 206:18 lung 20:3 37:21 38:5 89:6,10,22 91:1 93:14 103:4 103:7,8,10,14 267:13 348:22 349:13 358:19 359:3 lung-counting 362:16 lung-exposure 402:7 Lynn 2:6 6:5 <hr/> M <hr/> M 1:23 19:21 377:10,12 MAC 99:11 365:13 machine 371:2 machining 232:10 MACs 100:13 magnesium 248:4 248:7,11 251:1 magnitude 265:10 268:10 287:12 294:20 295:7 301:22 339:4 main 47:6 246:13 276:12 maintain 268:7 maintained 177:16 maintaining 353:11 maintenance 127:16 major 159:14 223:20 266:16 309:13 345:20	majority 30:14 150:14 248:1 253:20 289:4 317:14 Makhijani 2:6 5:21 5:21 6:2,3 46:20 73:20 79:11 113:10 126:21 128:7 160:3,9,12 162:7,17 163:3,8 164:3 166:13,17 167:2,8,14,18 171:15 172:7 173:2,5,11,18,22 174:6 182:2,10 188:16 204:6,11 209:6,11 212:5,16 213:8,13 214:9 217:3 218:13 219:3,10,14 225:17,20 226:16 226:18 227:5,11 228:21 229:19 230:6 238:5,9,17 239:16 253:5,12 254:9,19 255:9,11 255:17,20 256:3,7 256:13 257:10 259:22 264:16 265:2,14 266:2,9 274:6,15 275:16 275:20 276:2,19 277:3 284:21 285:5,10 286:16 287:10,13,20 288:9 293:8 295:18 298:19 300:13 301:3,7,15 302:4 making 44:19 48:15 58:9 73:13 128:19,21 223:11 248:19 264:11 288:20 323:9 man 387:10 manhole 316:16 320:10 336:13	manholes 336:12 manner 129:8 385:15 manufactured 289:5 map 71:14 March 16:4 149:2 150:20 215:1 216:12,17,18 316:10,20 359:6 359:13 362:5 369:19 384:12 392:1 398:6 411:19 marching 146:18 mark 1:20 2:2 3:21 4:16 33:7 42:17 88:8,14 97:1 102:6 110:15 111:18 116:3 133:14 142:3 153:6 154:17 157:12 174:8 182:3 184:15 204:6 206:20 221:8 235:1,2 258:21 272:20 273:13 300:14 350:9 396:15 402:7 marked 12:4 Mark's 118:21 119:1 179:9 Marriot 1:15 mass 224:3 229:13 236:1 241:3 260:21,22 262:4,7 268:9 283:19 284:6 285:1 301:17 302:5 336:19 379:11 masses 301:14 massive 340:9 342:17 404:9 match 26:5 111:12 111:17 181:14,18 194:7 399:4 401:5
--	---	---	--	--

matched 150:13	43:19 45:18,20	191:20 192:1,12	408:17,22 409:11	250:11,12 251:13
matching 401:10	46:2 47:15 48:1,6	193:14 194:4,11	409:15 413:22	251:14 252:5,17
material 9:11 11:7	48:8,11,14,18	194:15 195:17	414:9,18 415:3	253:9 254:11
22:9 103:17 137:1	49:2,7,12,16 51:9	198:16 199:6	416:3	257:20 258:3,5,9
154:19 222:1,7,8	51:12,16 52:1,4	200:9,19 202:1,5	max 224:20 225:6	259:1 273:14
224:3 246:20	52:10,14 53:13	202:14,18,21	maximally 293:17	275:18 276:10
261:2 266:6	55:5,9 56:5,10,19	203:2,5,8,13,21	maximizing 196:5	280:7,12 281:4
268:14 271:18,18	59:14,18 60:4,21	204:5 205:19	maximum 51:6,17	284:2 288:21
283:2 284:18	61:18 64:3,6,10	206:4,8,15 207:8	100:1 101:4	289:9,20 291:12
329:20 330:5	64:12,16 65:2,12	211:3 214:22	243:17 244:4	291:17 295:22
341:7,15,22	65:19 67:11,14,19	216:9,11,16,21	281:19 289:11	296:12,20 297:16
342:16 343:3,5	67:21 68:4,10,18	217:10,13,18	293:5,14 365:13	298:20 311:7,10
345:15 364:21	69:1,6,14 70:1,6	218:2,5,9 219:20	mean 25:20 27:22	327:18 333:22
367:5 370:7 404:9	70:20 71:1 72:1	220:2,7,10 221:1	29:16 39:18 42:18	335:8 343:8,8
materials 12:15	72:20 73:2,13	221:16 222:21	43:15 45:9 48:21	344:3,4 348:10
13:22 149:10	74:19 75:12,19	225:19 230:21	51:20 60:9 75:13	349:12 350:5
222:11 223:19	77:8 79:6,16 81:7	234:7,17 238:2,7	75:17 79:17 82:2	351:7 356:7 357:7
350:13	81:10 83:17 85:1	238:14 240:21	86:2 87:22 88:3	375:14,17 376:4
matrices 39:12	85:7 87:2,5,9 88:6	242:11 243:6	88:11 95:5,9	386:11 387:19
matrix 14:11,13,16	88:16 95:5 96:1,5	246:6,16,22 247:4	96:12 105:3	414:19
15:12,21 310:10	97:20 98:2,7	247:9 248:18	109:13 112:3,17	meaning 293:14
310:22 332:11	102:13 104:12	249:2 250:21	119:5 121:7,20	320:2 331:22
335:7 350:4	108:3,7 114:8	251:3,11 252:1,16	122:15 123:21	340:22
352:13 356:15	120:18,21 121:14	252:21 254:3	124:9,20 126:8,9	means 49:16 58:14
418:20	121:16 122:5	259:12,16 260:2	127:21 128:1	132:21 157:19
matter 26:17 39:5	128:4,10 130:13	260:19 261:16,21	132:7 134:10	249:7 276:3
40:6 46:8 80:4	130:16 133:4	268:11,21 269:11	135:4 141:17	279:21 333:11
98:15 118:13	135:9 136:21	272:19 274:4	147:15 155:4,6	342:4,6 406:16
189:19 199:15	137:13,22 138:21	279:8,18 282:4,17	158:2 161:16	407:11 414:15
212:10 226:20	139:4,12 140:11	283:21 284:14	162:4 164:6 166:8	meant 166:11
258:11 259:2	140:18 141:11,15	289:2 290:15	166:12 168:18	318:10 326:2
261:6 278:19	142:14,21 143:3,8	291:6,15 292:17	171:2,4 172:2	measure 319:8
298:16 303:19	144:16 146:18	293:2,22 294:16	173:16 174:2,15	measured 23:7
306:14 347:14	147:19,21 148:4,9	295:3,11,15 296:9	177:2 178:10,14	25:8 179:8 189:8
357:4 386:14	148:16 154:1,4,8	304:14 305:15	179:8,17 180:8	281:13 282:16
421:9	154:11,16 155:1	306:19 324:19	181:2,12 184:14	301:9 337:8
matters 110:8	157:11,21 158:14	327:13 334:4,10	185:22 186:2	measurement
Mauro 2:5 5:19,19	161:13 162:22	334:14,19 341:12	187:13,15 188:6	183:20,21 254:11
10:9,13 11:18,22	163:6 164:1	342:2 343:1,7,17	188:11 189:20	254:20 282:10,15
12:4,12 13:2,12	168:11,18,22	343:21 344:3,19	193:14,17 194:5	355:8 375:19
13:19 14:6,17,20	169:6,10,22 170:3	346:12 347:4,9	202:2,7,9 203:19	measurements
15:16,22 23:14	170:9,13 172:15	357:5 371:14	204:19 205:22	124:5 254:14
24:2 25:10,13	172:19 173:4,7	373:12,17,20	206:2 207:18	282:6 285:15
29:8 31:8,14,17	180:2 182:14,19	374:2 404:2,8,16	208:17 211:21	299:4 300:19
31:21 32:2,7 34:7	183:10 184:7,11	404:19 405:22	212:2 220:10	310:10 316:13,18
34:11 36:14 37:5	184:21 185:3	406:8,11,15,21	225:2 229:3	317:3,7 318:19
37:10 38:2 39:8	186:7 189:16	407:4,8,16,21	249:17 250:1,2,9	319:15 322:8

328:3,15,17	92:3,5,20 93:5,18	176:5,6,21,22	302:18 303:2	method 110:8
354:14 365:11	94:5 96:12 97:2	177:3,6,7,9,19,22	312:11,15 330:14	149:14 176:14
390:2	98:5 105:15,19	178:1,2,7 179:2	331:2 337:22	183:14 250:4,13
measures 316:14	106:3,6,17,21	180:4 181:8,12	338:5,9,15 339:7	291:9 365:18,19
mechanical 336:8	107:1,21 108:4,9	182:17 183:4	339:12,17 342:20	367:13
337:7	109:8 110:1,12	184:5,9 185:21	346:20,21 347:18	methodology
mechanism 388:5	111:4,18 112:12	186:8 187:2,6,10	348:5,9,21 349:5	153:16
median 25:20 65:5	114:3,6,18 116:16	187:16 188:4	349:10 350:2	methods 186:21
65:6 66:8 68:17	117:17 119:4,12	189:11,20 190:14	351:4,13,19 352:6	270:3 292:9 327:5
68:18,19,22 69:1	119:14,20 120:1,5	191:7,10,12,17,18	352:10 353:20	metric 47:6 223:17
69:21 71:12 73:6	120:6,20 121:21	191:22 192:2,6,7	374:3,10,15 392:6	227:3 228:3,9
medians 66:15 69:8	122:2 123:7,19	193:11 194:1,9,13	392:22 393:3,6,20	233:6 378:10
69:21	124:13 126:7,11	195:11 196:3,13	394:1,13,21 395:2	metrics 382:16
medical 271:2	126:19 127:8,21	197:22 199:1	395:3,10,17,19,22	microcuries 281:10
medium 386:4	128:5,16 129:2,11	200:18 201:22	396:5,11,16,18,20	microgram 77:19
387:16 399:15	130:22 131:5	202:2,7,15,19,22	399:10,22 400:5,9	micrograms 20:12
402:9	132:2 133:5 134:4	203:4,6,12,17,22	400:15,21 401:7	21:2 24:14 25:5
meet 18:16 150:9	134:10,13,19	204:10,16,17	401:12,17 402:5	78:6 164:14
261:12 419:9	135:4,11,21 136:5	205:4,5,9,11,15	402:13,16 404:15	microseconds
meeting 3:12 11:1	136:11,16 137:7	205:17,21 206:7	404:17 407:1	340:5
12:15 14:22 15:5	137:18 138:1,18	206:12 207:9,13	409:17 411:1,5,9	Microsoft 412:5
16:18 17:1,15	140:7,12,19	207:17,20,22	411:14 412:2,13	middle 210:16
21:10 43:20 44:14	141:13,17,20,22	208:2,5,16,20,22	412:16,19 413:1	311:3 417:11
44:14 45:13 46:9	142:1,5,6,13,15	209:2,10,15,17	414:10 415:2	migration 342:19
46:22 117:6	142:17,18,22	210:18 211:1,13	416:7 418:11,18	343:5
133:10 215:6	143:6,14,18 144:1	211:16,21 212:1,2	419:5,13,18 420:2	mill 77:7 85:20
246:16 248:21	144:4,8,19 145:3	212:15,20 213:6	420:6,18 421:5	106:10 107:13
305:19,20 352:14	145:5,7,9,17	213:19 214:1,2,5	members 3:14,15	108:21 248:14,15
359:7,16 384:13	146:9 147:17,20	214:12 216:7,10	4:9 7:15 8:3,16	286:19 288:4
392:1 421:7	148:1,6,14 150:16	216:13,19 217:4,6	9:9 113:9 149:17	322:9,11,19 323:2
meetings 39:18	150:21 151:5,9,14	217:8,11,15,20	memory 113:12	323:3 387:10
131:2 273:7	151:18 152:4,7,17	218:4,6,12,17	mention 9:7 115:15	milligram 215:11
399:14 404:4	153:5,15,21 154:2	219:8,13,16	130:8	milligrams 50:21
meets 213:18	155:2 157:20	234:19,22 235:11	mentioned 37:21	52:22 140:1
Member 1:20,21	158:7,15,17,19,20	235:15,19 236:4	110:21 164:10,21	197:15
1:21,22 3:21,22	159:1,3,5,6,9,12	236:12,16,19	251:2 312:18	million 246:2
4:1,2,3,4,5,6	159:20 160:1,7,11	237:2,6,22 238:20	mentioning 112:5	289:15
11:15 12:10,13	161:9,14 162:15	239:2,5,9,13,21	410:2	milliR 316:19
23:15 34:8 39:9	163:17 164:6	240:3,6,9,13,18	mere 36:9	317:9 319:7
41:2 42:15 43:7	165:6 166:8 167:5	258:16,19 260:11	message 50:22	320:21 321:8
43:11 45:7,19	167:13,17 168:16	262:2,9,13,20	met 9:17,17,19	355:8
46:1,18 47:21	168:21 169:20	263:3,12 264:10	16:9 150:8 279:2	millirem 316:20
48:2,7,9,12,16,19	170:6,11,14 171:3	284:1,15,20 285:1	283:12	321:4 342:4
49:6,9,14 52:12	171:8,18 172:9,11	285:4,7 294:14,22	metal 233:8 236:18	millirems 59:12
59:21 67:9,12,20	172:17 173:8,13	295:4 296:6,10	248:4 367:3	milliRs 317:20
88:10,17 89:1,4	174:4,8,12,20	297:6,12 298:4,7	370:11	millman 77:5,6,8
90:9,17 91:2,6	175:7,11,20,22	298:10 301:1,5,10	meter 365:15	78:3,12 80:7,8

93:6	156:18 179:14	361:10 362:16	117:14 135:14,22	National 1:8
millmen 77:17	185:10 204:4	385:3,4 386:7,20	136:8 144:10,22	326:20,22 327:16
82:12 83:12 84:6	205:6 212:17	399:18	145:15 146:5	328:22 346:9
90:8 95:6,10,17	214:3 335:14	modeled 104:8	209:13 218:15	natural 223:18
120:22 159:16	mission 132:18	modeling 179:3	332:18 333:13	227:22 228:9
millrights 171:14	248:21	314:2 337:18	334:16,20 338:4,7	233:4 236:17
mills 323:3,7	mistake 238:19	393:13	338:11 344:15,21	341:11
millspec 133:16	mitigation 368:8	models 23:10 35:22	348:7 358:5,16	nature 197:10
146:22	mix 22:7 215:8	42:2 86:5 132:11	366:12,14 379:2,8	336:7
millworkers 87:13	216:4 222:1 231:2	327:22 344:14	379:15,22 382:17	near 311:2 314:9
mind 9:10 18:22	238:15 240:22	modest 333:12	383:3,7,10,14,22	nearly 319:22
56:11 60:14 70:17	292:1,3	modification 321:5	386:11 387:2,13	necessarily 159:4
71:3 74:20 79:4	mixed 264:5	324:1	388:8,17,20 389:7	264:7 292:7 346:7
112:8 120:17	mixture 275:6	modifications	394:11,17 399:20	349:3,22 351:6
128:12,14 182:17	292:11 365:5	309:19 324:7	400:2,13,19 401:1	401:19 408:13
267:8 290:7	386:15 389:13	340:13	401:8,13 402:3,6	necessary 302:7
294:19 298:11	model 16:7 17:2,2	modified 341:4	403:16 404:7	375:16
309:9	17:11,12 18:1,21	mold 364:17	405:6,18 413:9,15	necessity 44:12
Mine 12:4	19:2,6,9 22:4,6,21	moment 310:3	move 26:16 55:16	need 9:4 10:22
mined 322:8	24:12 26:12 28:13	311:5 321:4	56:3 61:4 65:12	17:10 30:12 42:16
minimized 196:6	30:13,22,22 32:10	331:17 335:6	118:3 176:14,20	42:21 51:3 72:7
minimum 23:4,5,8	33:19 36:4 37:6,7	money 172:5	279:20	118:22 123:17
23:20 79:5 129:14	37:8 39:15,20	monitor 374:14	moved 190:12	134:1 135:5,12
142:4 243:18	43:16 44:17,19	monitored 36:10	224:4	137:15 141:3,15
minor 26:14 302:3	45:1 52:17 53:4	47:4 59:4,10 88:1	moving 36:13	144:22 148:5
minute 55:1 62:13	53:17,22 54:9,20	88:5 172:13	50:12 141:19	161:9,17 171:6
192:14 318:7	55:2,6 61:21	179:19 185:6	336:9 379:11	178:5 188:9,13
320:14 328:11	62:19 63:21 65:8	186:20 189:3	multiple 95:16	196:14 214:18
376:5 391:8	66:11,16 67:3	209:4 291:14,16	277:4 373:21	225:13 234:13
minutes 3:10 40:16	70:12 71:16 74:2	monitoring 47:7	379:17	238:9 258:22
40:17 118:11	74:12 75:1,9 76:2	89:15 124:9,18	multiples 365:13	259:7 267:8
304:16 340:6	78:19 80:2 81:3	170:21 204:14	multiply 364:2	269:15 270:12
misinformation	82:3,7 85:5,12,15	208:15 272:12	multi-colored	274:3 296:15
231:1	86:3 87:15 90:1	348:19	372:6	302:22 310:15
mislabeled 219:1	93:8,12 101:2,17	month 47:9 90:6	mute 8:11,22 9:2	327:19 330:8
mislabeling 217:19	106:8,8 107:5	115:7 180:10	118:10 303:16	339:8 340:14
mismatch 181:21	112:15 113:4	monthly 186:10		345:19 346:5,10
181:22	120:10 121:12,18	195:6 201:17	N	351:11 381:18
mismatched 24:1	131:13,21 136:13	months 130:5	N 3:1	385:17 387:2
misrepresent 19:5	136:15 157:1	218:20 366:6,7	naively 390:17	389:1 403:22
misrepresenting	179:12 183:7	morning 3:3 42:18	name 3:6 150:16,22	405:4 406:18
215:21	215:9 221:22	136:10 161:8	151:3	409:8 413:21,22
missed 33:12	231:7,8,9 313:20	387:8	named 369:5	416:16,19 417:3,5
124:12 125:6,14	313:21 325:4	Morris 2:3 4:18,18	names 18:11 369:6	needed 277:10
125:16 349:16	328:7 329:21	31:6,9,15,18 32:1	Nancy 2:10 8:10,14	needle 33:10
399:12	334:5,15 337:6	32:3 43:2 52:2,5	8:14	needs 18:17 65:13
missing 150:11	339:2 344:11	53:5 72:15 73:1,9	narration 235:17	413:1,18 421:3

negative 345:15	243:2 246:9 247:2	417:17	328:6	190:2 191:14,15
Neither 39:8	252:19 253:11,15	Ninety-fifth 402:13	nope 152:22	195:7 196:1 199:2
neptunium 22:8	257:20 258:3,14	Ninety-nine 245:19	normal 137:13	200:21,22 201:5,7
237:14 243:12	258:21 260:4,12	niobium 219:2,6,7	249:16 269:16,17	202:13 203:19
279:21 280:4	264:6 270:4	niobium-95 218:19	normally 385:6	212:6 223:12
281:9 286:4	273:13 274:14	NIOSH 2:2,2,3,4,4	note 316:12,17	229:22 241:9,12
neptunium-237	275:14,17 276:1	2:5,10 4:13,16,22	362:7 365:16	241:12 243:1,1
215:13	288:19 289:3,8,17	5:15 8:15 12:1	notes 165:1	252:3 259:6
nested 139:6	290:10 291:4,13	16:6 17:1 19:3	notice 15:3 23:3	262:11 263:22
Neton 2:2 4:14,14	292:15,20 293:12	37:17 41:18 46:14	257:5	268:17 269:4
23:1,18 29:5	293:20 295:6,13	85:3 88:22 104:19	notion 324:13	273:4 274:9,11,16
32:21 35:20 37:4	296:18 298:2,5	107:8 109:14	notwithstanding	287:4 288:5
37:8 42:13,16	302:22 303:10	110:1 114:17	62:8 231:2 238:16	301:11 306:11
43:4,10 49:3	326:11 327:14	115:4 116:10	novel 346:8	307:10 308:14
52:15 53:9 55:3,6	329:12 333:21	117:22 119:8,20	November 9:19	309:20 311:7,15
59:1,16,19 60:1,8	334:8,11 340:15	120:1 124:11,22	304:21 306:22	314:9 315:21
64:2,5,8,11 68:2,5	341:5,14 342:15	132:20 133:3	307:2 314:17	317:10 326:3
68:15 69:4,11,20	342:21 343:2,15	143:17 155:12	317:18 319:5,9	338:13,17 359:8
70:4,14 71:18	344:1 346:5 347:1	174:21 183:7	369:19 377:19	373:14 385:13
75:16 77:7 79:3,7	347:8 349:8,12	197:4 206:1 211:6	NRC 336:17	391:7,15 400:4
81:5,8 83:15 84:2	350:21 351:11,15	211:8 215:5 219:5	NTS 46:4 173:20	numbering 238:19
85:2,16 87:3,7,19	352:3,9 355:22	253:6 280:8	189:9	numbers 26:11
88:8 92:11 93:10	356:17 357:6	295:21 296:4,17	nuance 147:1	34:15 37:14 56:22
94:4 96:8,14 97:4	Nevada 162:9	302:19,21 304:7	nuances 296:20	58:2 62:20 64:20
97:22 98:9 99:13	167:15 188:21,22	305:3 306:6	nub 80:4	67:18 78:8 116:1
99:16,18 100:14	189:15	312:18 313:3	nuclear 265:6	193:3 194:8
100:18,21 101:9	never 37:12 88:4	329:14 346:21	336:22	201:19 213:21
101:11,16 103:2	178:15 185:14	350:10,14 355:21	nuclides 215:14	222:16 241:6
103:22 104:13	189:8 355:11	359:15 360:11	279:13 292:7	242:20 253:9
105:17 106:1,4,9	359:8	384:13 385:12	377:11	262:22 263:13,15
107:19 108:14	Nevertheless	392:9 406:18	number 17:14,15	264:17,22 265:13
109:20 110:10	183:16	415:7 419:19	18:5,10 26:1	265:15,18,21
111:8 114:10	new 47:13,14 56:15	420:1	37:16 38:5 44:9	266:4 269:15
121:9,15,18 122:4	64:16 115:9,19	NIOSH's 46:19	50:1 51:6,17 57:1	281:8,16,17 283:3
123:12 124:2	116:21 132:12	174:9 305:9	57:1,22 58:1,3,11	285:15 287:16
129:6,14,19 130:7	221:13 346:11	307:13 308:12	58:12 63:22 64:22	288:1,18 290:3
130:15,19 131:8	news 115:20	313:18 372:9	66:20 77:9 78:7	298:1,13 299:18
131:14,21 170:16	nice 170:9 184:19	386:2 420:17	81:14 91:16 92:14	300:1,11,15,18
171:5,10 176:12	304:15	nitrate 261:9 370:8	97:7 107:10	301:6,8,8 305:8,9
177:8,16,20	night 14:21 44:15	370:16	108:15 113:19	320:19 324:2
178:21 179:16	86:19 102:14	noble 328:21	114:12,19 120:7	325:13 329:8
180:16 181:10	147:14	NOCTS 90:14,21	125:18 140:1,9	333:4 337:14
182:9 184:13	nine 227:15 354:11	91:22 92:7 96:13	145:13 158:9	340:14 343:8
185:1,4 187:4,7	366:7 367:2,2	96:14,15 113:20	159:13 167:19	344:10 409:7
187:12 188:1	368:20 370:2,15	119:10	169:12 173:16	number's 347:19
190:9 232:1,2,18	370:17,19 374:6	nomad 204:21	187:21 188:2,9,11	numerous 9:20
233:10 234:15	406:9 416:12	non 108:18 163:4	188:17 189:4	314:3

nutshell 304:19	359:8	119:13 120:5	70:16 111:9	operations 20:9
O	odds 273:12	121:14 122:5	115:15 140:21	28:10 125:5
O 3:1 133:16	offer 25:15 295:16	123:14 130:7	181:17 188:2	127:14,19 234:10
134:16,22 146:20	296:18 334:12	131:7,16,17 132:1	220:18 223:14	366:2 367:20
151:15,20,22	office 169:8 205:8	135:21 136:5	232:21 259:1	396:7
152:6 153:9,20	210:15 238:18,22	139:20 148:16	270:19 319:12	operator 77:7
359:17 360:19	239:4 253:10	151:6 152:17	341:7 357:10,13	86:21 88:4 106:2
408:2	262:4,10,12	153:11,21 154:7	402:22	106:5,10,10 127:7
Oak 223:8 299:22	299:16 300:14	154:22 155:8	onerous 97:9	156:6,8 179:11
objected 244:15	offices 8:17	156:5 170:2 176:7	109:16	operators 85:20,20
objection 190:10	official 1:23 3:7	178:16 183:22	ones 10:7 33:17	90:7 94:7 108:21
objective 302:6	136:14	190:15 191:12	34:6 66:16 80:11	108:21 181:6
objectives 17:16	offline 389:4,6	193:5 195:11,14	94:2 95:8 151:20	opinion 58:14
observation 25:16	Ofentimes 86:15	199:9 202:18,21	151:21 178:3	101:20 127:22
32:22	97:16	203:6 204:5 213:7	180:10,11 192:2	156:16 162:21
observed 28:3	oh 8:7 13:5 42:15	216:19 217:13	274:8 293:4	189:2 260:13
402:11	63:11 88:10 89:4	218:12 219:8,17	316:11 381:16	327:3,9,15 328:20
obtain 270:16	120:5 134:8 144:8	226:19 234:17	387:4 404:11	opinions 327:12
obtained 24:7	184:11 190:6	239:5 240:7 241:5	405:8 409:9,11,13	opportunities
270:2	269:6 285:7 318:3	247:9 249:20	409:18 420:8,9,10	98:18
obvious 52:21	334:4 335:6 383:7	250:21 251:3,11	one's 397:1 400:3	opportunity 221:11
obviously 111:13	406:8 413:14	252:16 254:3	one-pager 141:14	opposed 37:5 246:1
128:1 129:3 137:9	416:7	259:14 262:9,9	ongoing 56:13	261:22 377:7
138:5 162:4	Ohio 229:13	270:10 279:11	online 392:8	option 168:5
169:13 217:18	231:18 238:18,21	303:11 304:11	onward 268:19	options 83:20
229:19 262:15	243:9 245:3	307:7 312:15,17	on-site 90:5	166:14
276:12 281:15	247:18 253:10	331:2 334:21	open 15:9 61:14	oranges 395:1
288:6 321:10,17	262:3,10,12	339:7 344:1	153:4 166:18	ORAU 2:2,2,3,4,4
331:8 354:7 382:8	264:22 299:16	346:17 352:12	249:11 319:20	2:5 4:13,18,20 5:1
414:21	300:14	355:17 357:9,18	364:17 399:20	5:2,8,12,15 92:19
OCAS 88:22	okay 4:7,12 5:17	357:22 372:15	opened 290:15	94:16 96:16
149:17	7:2,14 8:19 10:12	374:2 383:19	opening 18:22	149:17 295:21
occasion 289:14	11:13,21 12:3,18	385:10,19 387:12	317:13	392:20
OCCUPATION...	14:8 19:19 20:7	389:5 392:22	openings 309:15	order 11:10 34:17
1:8	22:4,20 23:14	394:13 397:9	336:10	35:6 76:8 78:1
occur 228:17	24:2,5 25:17 26:2	398:12,17 399:1	operated 318:5,8	189:5 195:4
occurred 36:7	32:1,13 40:2,17	400:5 402:5,14,15	320:15	211:22 213:18
59:15 100:6,13	41:6 42:15 48:17	402:17 406:8	operating 56:13	265:10 268:9
105:3 309:13,20	53:16 58:15 60:4	410:11 414:4	245:10 318:14	301:22 339:4
333:6	61:12 64:4 65:2	415:18 416:4,12	328:12 354:20	375:16 381:21
occurs 310:13	65:19,20 66:4,22	416:15,18 417:16	operation 210:16	406:16
329:12	67:12,19 68:4	418:2 420:22	275:2 276:5 277:2	orders 146:18
octave 213:5	70:5 71:18 72:14	421:2	301:14 314:17	287:11 294:20
October 14:22 17:1	75:19 79:2 80:6	old 350:6,7 415:5	318:20 319:4	295:6
47:1 115:17	80:20 89:4 91:4	older 388:15	354:15 365:9	ore 322:8,9,11,15
163:11 166:18	96:7 99:13,16	once 22:4 30:9 35:1	396:8	ores 223:17
	114:3 118:9	47:9,9,9 50:12	operational 366:10	organ 19:22 20:18

103:12 357:11,12	295:9 364:6	13:6,14,16,18	parsed 167:10	247:17 250:16
organic 277:17	393:22	26:4 61:2 240:16	part 42:4,5 89:17	251:9,22 253:21
organization	overboard 254:7	265:5 367:9	98:10 130:18	254:1 259:13
305:13	overestimated	419:14	132:7,17 157:9	268:8,14 272:21
organs 259:17,21	93:16	pain 53:10	177:3 187:8 188:3	273:19 274:1
295:5	overestimation	paint 345:8	189:22 191:22	279:10 281:8
orifice-driven	327:10	painter 80:9	202:9 218:17	284:8 288:22
339:11	overt 52:17	paper 51:5 73:21	236:2,7 241:9	289:15,20 290:12
original 46:6,11	oxide 370:9,16	74:1,20 102:8	248:20 263:17	298:5 299:15
170:17 171:15	P	136:6 173:5,7,10	264:4 265:3	passed 214:19
172:20 184:20	P 1:19 3:1	214:11,13 215:5	268:12 276:4	passing 330:11
190:10 242:13,16	PA 304:20 307:4,5	220:1 225:1,22	286:22 307:11,20	pasted 219:4
242:19 274:18	package 314:1	226:6,12 234:13	308:18 312:1	227:16
282:19 283:14	321:12,12 331:18	239:17 247:12	348:11 351:5,6	pasting 205:16
329:11 358:15	332:5,11	264:18 286:7,18	400:11	path 39:13 72:13
382:20 383:17	Paducah 246:9	286:21 288:12	partial 207:3	187:13 336:15
393:10 398:20	254:12,17 262:22	295:20 296:4	PARTICIPANT	407:22 418:9
404:5 406:2 408:5	284:3,6 285:2	297:10 299:19	61:16	paths 336:14
408:20	297:21 299:21	302:19,21 303:4	participants 2:1	patterns 158:21
originally 171:11	Paducah/Fernald	304:8,19 305:22	13:14	192:10
236:6 325:14	297:17	306:21 333:15	participated	paucity 386:8
398:8,21 408:1	page 13:8 16:5	338:22 339:3	246:20	Paul 1:21 4:1 67:8
409:18	18:22 19:7,17,17	358:16 359:20	particles 248:16	155:5 173:19
originated 232:14	20:4 24:8 26:18	367:1 373:1	341:19	221:9 234:19
274:22	27:8,12 51:19	385:22 387:6	particular 27:19	304:10
oscillates 321:3	56:20 57:13,20	388:6 389:1	28:9,10 32:9 57:6	pay 71:15
oscillating 370:9	61:7,8,12,14,14	396:21,22 397:2	127:2,3 281:7	PA-cleared 10:8
OTIB 130:15,16	61:19 62:21 64:19	400:6,8 401:1	308:4,14 317:2,16	16:3
135:18 303:6	75:20 76:19 77:2	402:19 403:6,21	319:14 328:1	PDFs 164:19
OTIB-4 183:13	78:17 203:11	412:3 413:11	356:1 362:18	peer 330:12
ought 208:3 211:1	205:19 216:5,6,21	414:5,8 418:12,17	363:4,4,12,13	penetration 320:9
outcome 21:19	217:5,9 219:6,12	419:19 420:17	364:8,14 365:4,9	penetrations
44:1 102:16	224:10 227:1,14	papers 10:5,6	365:9 366:2,5	309:16 319:19
112:21 121:7	227:15 235:5	115:9	368:20 369:4,16	333:12
181:19	241:1 249:10,20	paragraph 217:16	370:2,13,14 371:4	people 33:14 34:13
outliers 250:8	256:11,16,16	parameter 122:10	374:8 377:17	35:14 38:21 39:3
outside 13:16 96:15	306:22 309:2	parameters 30:1	381:14,22 382:16	42:7 54:5 55:7
116:5 125:20	310:14 311:21	63:19	388:6 389:14	58:3 59:8,10 61:3
273:20 349:20	312:16 314:6,9,10	Pardon 216:9	390:7 397:17	81:9 84:13,20
outstanding 242:7	314:11 316:1	255:10	413:6 415:22	86:4,15 95:21
out-of-specificati...	318:4 319:3	parent 322:14	particularly 227:9	107:10 111:21
271:18	320:20 322:12,21	parentheses 66:2	368:19 384:17	112:14 116:5,20
overall 63:21 123:9	330:17 354:11	314:18	parties 409:3	117:2,2 120:7
150:12 155:21	pager 141:16	parenthetically	parts 140:8 233:8	121:19 125:1,14
156:2 203:6	pages 10:16,17,21	245:16	236:18 241:3,16	125:16 126:12
207:10 212:21	11:1,6 12:21 13:3	park 34:4	241:18 243:4	128:2 130:3
236:2 241:12		parse 24:20 85:19	244:1 246:1,1	135:12 158:21

174:2 180:19,22	79:4,9,15 85:22	204:3,21 206:15	picture 32:4 57:18	379:19 392:21
181:1 190:17	86:4,6,10,11 87:1	241:13 364:7	201:13 349:7	406:2 408:5,17,19
212:8 242:1 243:6	87:18 89:21 109:4	401:5	403:2 408:12	415:5 416:5,8
266:21 273:12	122:9 125:3	personally 162:9	413:8	planned 278:19
312:20 314:13	130:11,17 385:6	171:21 266:19	piece 67:6 83:13	415:10
327:11 328:21	386:18 399:21,21	personnel 315:7	240:17	planning 13:7 15:3
348:22 349:4,22	402:8,10,12	361:13 369:5,8,21	pieces 20:21 99:5	383:13
369:1	percentiles 391:3	person's 54:20	378:13	plans 143:13,19
people's 420:11	percent-plus 49:4	82:18	pile 330:5	409:5
percent 16:15 21:3	perfect 368:22	perspective 73:21	pilot 368:21 369:11	plant 71:20 72:19
21:5,14,17,21	perforation 345:14	126:1,2 221:2	379:19 416:7,11	73:6 74:5 75:2,9
22:14 30:11 33:4	performing 226:7	356:11	416:20 417:1	84:15 98:12,13,17
33:5,7 34:2,16,17	perimeter 348:18	pertains 369:4	418:5	99:12 111:1,22
34:20 35:1,8,9	period 21:16 24:19	pertinent 409:10	Pinney 350:16	112:1,5,7,8,10,11
38:7,11 44:3,3,8	57:6 80:1 82:14	409:18 413:5	351:2,16	113:13,17,19,22
48:20,22 50:1,13	85:13 99:7 100:22	416:22	pipe 336:11	114:4 167:11
57:3,8,9 58:14	124:6 125:21	petition 126:19	pipes 309:16	179:20 190:13
62:10,11 65:21	129:3,20 192:21	132:6 307:12,14	pits 248:10	191:16 223:15
67:11,12 71:8,8	201:8,11 208:7	307:15	place 17:12 24:17	224:17,17 232:22
72:18 81:5,9	209:4 212:9,17	petitioner 2:13,14	29:21 66:19 73:4	233:2 234:2 237:8
84:20 89:8,11,21	230:14 233:5	2:15 7:19 8:6	147:6 153:14	237:17 244:21
91:12,14,15,18	241:14 255:7,7	12:10	200:11 252:4	245:22 246:10
92:2 98:3 101:15	263:6,10 276:8	petitioners 7:15	324:1 359:13	248:2,4,14,17
102:2 123:3	277:12 282:8	157:5 190:18	362:2,3 368:2	253:22 261:7,11
137:10 147:7	299:1 309:11	petitioner's 353:3	388:16 391:22	264:5,7 265:22
150:12 152:12	313:8 323:22	Phillip 1:22 4:5	407:10	266:1,8 277:9,17
157:14 158:4	329:18 340:7	philosophical	placements 74:6	278:2,10,12,13,13
167:9 170:20	354:21 359:2	286:13	places 27:6 66:13	278:15,21,21
188:19 189:2	363:14 364:16	phone 8:22 9:5	73:3 222:12	279:2 284:7
216:1 245:19	367:3 369:16	118:10 200:15	plain 244:12	288:15 289:14
267:15,19,21,22	374:19 393:19	303:16,21 312:21	plan 9:22 10:10	290:14 293:7
270:21 272:6,7,14	periods 38:21 47:5	398:11 399:12	11:14 14:15 16:2	360:7 361:20
278:8 290:9	62:17 70:8,9	421:7	16:6,10,10 17:14	367:2 368:20
311:12,12,18	79:19 85:2 99:11	phones 199:13	17:18,20 18:6,12	370:2,6,14,15,17
318:15,17 319:16	100:12 242:1	physical 41:1 337:8	18:16 26:21 31:1	370:17,19 373:13
321:21 323:6,7	243:3,7 283:1	physically 53:1	33:2,9 43:20 44:2	374:6,22 375:5
331:9,10,13 332:1	294:9,13 361:14	physicist 4:17	44:5 46:21 47:2,8	380:14,16 391:6
332:19 341:21	permeates 365:17	physics 104:18	47:11,14,17 53:15	396:6 401:18,18
349:13 357:14	person 52:5,7 53:5	pick 15:13 30:1	54:4,14 74:3,7	401:19 405:11
375:13 382:10	53:8 82:6 97:15	53:17,19 54:5,8	83:2 131:11,19	406:6 407:18
384:8 413:20	99:21 101:5 122:6	80:8,13 103:5	139:14 140:15	410:8 411:4
percentage 50:7,14	129:4 139:1 179:7	122:8 213:16,21	141:10,14 144:13	415:15 416:11,12
percentile 23:12,21	185:19 186:9	picked 48:10 53:6	148:5 149:13	416:17,20 417:1,4
25:6,6,22 28:14	192:20 193:10	62:20 86:12	161:11 162:9	417:7,10,14,17,19
28:14,21,21 64:9	200:21,21,21	404:10 409:18	163:10 166:18,20	418:5,5
65:7 75:6,7,11	201:1,15 202:13	picking 364:21	171:11,15 188:6	plants 56:13 75:4,9
78:11,12,13 79:2	203:10,11,15	Picocuries 64:12	200:4 220:15	75:14 111:2

223:12 233:1	54:7,12 60:20	123:10 126:3	84:14	presumably 226:13
244:13 245:5,15	69:7 73:15 74:22	146:7 162:6,19	pound 281:10	299:6
246:5 257:9	75:17 84:11 92:21	175:9 270:18	pounds 229:11	presume 280:21
266:17 284:19	108:1,10 116:19	290:9	pouring 364:17	pretty 22:20 32:16
360:6,9 361:17	126:8 138:3 141:2	portion 337:6	ppb 287:4	78:14 102:11
370:3 372:22	162:10 164:8	375:11 377:2	practical 296:11	104:17 108:13,20
406:3,5 407:5,6,8	172:18 187:15	portions 308:18	300:6 380:7	111:20 115:8
408:21 409:7	204:8 216:6	posed 183:11	practice 113:18	122:18 153:22
415:16,17	222:18 229:18	position 283:5,13	pre 328:15 332:13	162:17 174:3
plant's 276:21	243:9 261:11	308:21 326:5	340:1 355:14	178:15 186:18
plate-out 341:15	263:14 264:10	337:20 386:5	precautions 254:15	189:9,10 194:14
play 89:17 332:7	267:22 273:14	positions 369:9	precise 371:13	247:16 251:9
345:1	284:2 289:18	positive 54:19	predefined 167:21	286:8 291:18
plays 340:18	300:8 302:3	possibility 108:10	predict 325:6	296:11 297:20
please 4:13 5:5 6:1	321:17,17 323:10	291:19 333:5	336:21	328:19 341:7
9:3,9 19:6 68:11	330:1 331:19	possible 11:3 13:15	predicted 337:6	349:8 372:11
194:19 217:7	355:7 356:6,11	28:13 30:3 58:18	prediction 101:3	390:5 399:7 419:3
221:8,13	359:14 364:9	82:12,13 83:10	preface 18:18	prevailing 336:3
plenty 36:21	365:16 366:8	87:8,22 88:2,3	preliminary 362:4	prevent 36:11
114:21	375:2 385:12	92:19 93:3,11	364:10 414:14	309:17 342:19
plot 389:19	402:19 410:16	95:2,16 129:1	premise 280:9	343:4
plotted 269:20	414:14	286:2 346:19	prep 396:7	PREVENTION
plug 37:13	pointed 56:8	358:10,12	prepared 46:13	1:5
plus 247:21 349:13	236:15 272:5	possibly 101:22	102:8 115:13,14	previous 117:6
plutonium 165:16	300:9 325:8	107:6 217:1 258:8	306:8 359:7	157:10 194:17
237:14 241:19	pointers 73:17	353:17 397:13	presence 3:12	195:1 225:22
243:4,12 244:2,7	pointing 229:20	post 332:14 359:18	present 1:18 13:15	234:18 353:18
244:20 245:18,20	270:1	360:12	74:5 83:19 129:4	399:13 404:3
245:21 246:4,21	points 32:4 40:21	posted 60:12 134:6	presented 46:14	419:4
248:5 254:22	61:5 138:19 220:6	151:21 382:13,22	99:12 144:15	previously 16:9
260:1,7 268:7	220:14 223:1	397:11	163:10 166:6,22	115:2 146:6 313:4
271:17 275:4,8,12	296:7 301:16	posting 359:17	186:20 288:12	420:16
275:21 276:5,10	306:11 320:22	post-production	339:3 387:8	pre-1979 328:3
277:9,20 279:4	328:1 333:1	362:15	389:18	340:12 342:3,12
280:4 284:8 286:1	416:10	post-1987 340:11	presenting 219:22	346:2 353:10
286:3,3,9 287:1	poised 11:11	potential 17:21	220:6 350:6	355:9
288:22 290:13	policy 59:14 60:6	18:2 35:17 45:16	presents 24:10	pre-1980 319:18,21
291:14 292:5,14	pooled 29:18	59:3,12 77:22	presiding 1:17	primarily 150:2
292:22 295:10,11	poor 358:8	123:10 165:19	Presley 1:21 4:3,3	222:12 223:7
298:18	POOS 244:7 266:6	168:3 267:16	208:16,22 209:17	224:14 229:7
plutonium-239	271:17	315:2 363:3 364:7	211:16 212:1	237:13 243:11
22:8 215:13	populate 94:20	364:15 378:22	216:7,10 217:6	260:21 287:7
POC 93:21 110:5	populating 400:10	386:4 387:1 402:8	presses 27:16	primary 132:22
point 23:1 26:14	400:12	potentially 33:21	pressing 356:10	224:12,13 257:4
31:9 35:20 36:15	population 31:11	85:5 89:20 102:3	pressure 313:13	260:20
41:3,18 48:15,17	31:12 37:19 39:7	105:2 273:9	314:2 337:2	principles 414:1
49:18,22 52:15	49:4 63:20 71:20	potentials 33:17	345:15,16	printer 218:16

prior 130:5 226:13 228:17 234:14 261:10 314:17,20 316:13 320:6,22	290:17	354:5	proportion 375:12	pure 290:3
priori 138:5 140:13	procedure 132:8 137:13 178:13 193:7	production 149:10 189:15 190:13 208:17 246:11,13 246:14 362:1,2 367:3 369:14,20 370:10,11,16 371:18 372:1,20 377:22 378:9,12 381:16	proposal 119:5 125:8 413:17	PUREX 261:7 277:18 278:3,13
prioritize 141:6	procedures 130:18 178:12 179:21 194:7	productive 80:5	propose 32:8 35:18 45:14 117:19 118:4	purified 292:8
priority 381:20 420:8	proceed 142:11	products 22:9 116:15 261:8 275:7 276:7,9 278:14 280:22 281:2 282:2 286:3 286:8,10 289:15 292:2,3 293:1,9 293:11 294:19 315:3	proposed 44:2 85:5	purist 62:14
Privacy 9:10 13:22 14:4 392:14 410:20 411:17	proceeding 420:16	professional 259:9	proposing 31:10	purpose 10:22 50:18 74:20 310:1
probability 38:7,12 89:8,11,22 91:14 91:18 92:2 123:2 267:15 270:21 272:14	process 21:22 54:7 55:12 59:11 73:16 93:13 120:17 135:17 182:15 198:22 216:3 229:14 231:14,19 243:21 247:13,20 247:21 248:6,12 268:18 276:3 278:17 280:19 285:22 288:4 298:6,22 301:14 307:4 315:12 330:12 349:4 356:4,12 366:1 370:10 414:2	professionals 229:17	protect 294:3	purposes 215:19 361:12 381:10
probably 8:22 11:9 12:8 33:6 34:3 52:6 53:11 62:9 84:8 106:5 107:22 114:18 119:17 125:9 143:20 145:14 171:6 179:11 205:2 207:11 220:18 241:16 267:3 275:18 285:13,17 294:20 308:17 326:4,12 344:1 360:9 378:20 383:15 395:21 401:2 403:9,12 409:2	processed 236:21 252:8 266:7 270:9 279:15 307:15	progeny 325:20 326:1 340:17 341:18	protection 247:6 291:11	pushing 105:3,7 122:15
probe 290:19	processes 193:6 301:13 367:11 368:1	program 53:14 59:7 152:21 180:7 201:16 246:21 349:14 358:20 359:3	protective 82:3	put 9:22 15:12 17:12 42:19 61:13 61:15 62:13 65:21 82:19 102:17 128:20 134:16 144:6 146:20 160:22 165:15 191:3,3 193:2 203:2 204:18 207:4 217:6 229:14 236:1 258:11 266:22 267:22 303:16 342:16 343:3 356:5 358:4,6 378:21 401:2 411:22 415:3
problem 27:18 28:18,20 29:2,11 39:17 41:1 71:13 79:12 81:13 113:20 128:11 143:19 156:1,15 156:17 160:18 172:2,12 173:12 179:4 213:16 232:7 275:4 347:12 388:9	processing 223:17 224:16,17 268:14 275:6 276:21 278:9 289:12 368:22	proof 177:17 185:7	provided 192:20 363:22 383:5 384:6 408:2	puts 253:3 388:2
problems 27:17 53:14 232:17,19	processors 277:5	properties 337:8	provides 211:6 337:19 367:15,22	putting 206:5,18,19
	produce 120:3	property 100:22	providing 278:17	p.m 199:16,17 303:20,20 421:8
	produced 145:10 290:2 338:22 370:20 371:21		public 7:16 8:3,16 9:9 11:17 190:21 223:22 326:18,19	
	producing 223:18 233:8 370:8		published 224:1,6	
	product 116:8 122:1 202:4 261:6 279:2 281:6,20 290:2 292:12		Pugh 257:7	
			pull 28:11 63:12 66:5 77:4 85:19 88:19 96:10 97:5 97:10 109:7 191:13 235:1 284:3 300:22	
			pulled 111:14	
			pulling 111:14 113:12 151:12	
			pump 340:17,21 341:7	
			pumping 354:2	
			pumps 314:22	

Q

qualifies 234:3
qualitatively 189:6
274:19
quality 180:5,7
358:9
quantify 110:10
quantitatively
257:12
quantities 222:7
224:3 227:3 233:6
quantity 152:16
quantum 339:20
quarter 24:16,20

24:21 27:13 34:12 55:15 57:2,3,11 57:12 70:19 199:10,12 303:15 350:4 quarterlies 68:13 69:13,15 quarterly 25:3 68:5 68:7,8,16 69:9,18 178:17,22 179:19 181:6 195:6 201:18 quarters 79:2 180:10 quartile 62:8 queried 89:6 query 88:21 90:14 90:21 91:21,22 92:3,8 question 12:22 13:11 19:19 20:20 22:1,22 30:19 31:7 32:2 34:12 39:13 42:3,6 43:13 47:19,22 58:17,21 59:2,22 62:4,22 63:17 64:15,16 65:15 68:2 73:10 75:20 82:11,19 88:13 90:10 93:6 96:2,6 98:11,20 102:21 110:15,15 124:3 124:18 126:17 131:11 132:4 143:11 145:18 146:3 155:4,5,8 156:19 157:11 159:17 161:12 169:18 177:1,4 178:5 179:17 183:11 185:5 190:8 193:9 195:3 197:1,19 201:21 207:10 208:14 211:3 217:9 219:21 228:17	241:2 253:1 263:9 266:3 274:7,16 275:8 288:20 290:18 293:13 298:12 300:7 321:15 330:15 332:3,4 339:19 347:19 348:13,14 350:3,9,18 351:10 357:1 373:13 380:9 382:14,18 383:22 392:9 393:10 403:21 413:16 414:11 questioning 39:14 200:3 questions 50:9 117:4 145:10 157:6 162:1 180:12 232:2 276:14 285:20 297:14 390:12 quick 13:10 57:19 219:21 346:16 353:6 373:12 quickly 57:18 91:16 95:3 133:21 146:1 183:14 192:22 194:12 195:22 307:8 quite 25:2,16 46:15 50:4 77:5 87:7 93:10 102:14 140:5 158:1 162:11 166:5 221:10 253:1,19 323:8 331:7 344:12 376:3 378:20 391:20 quota 378:10 quotation 312:20 quote 269:14 315:16 318:21 quoted 354:10 387:4 quoting 308:17 Q-11 349:4 350:18	R	335:3,11,15,18,19 336:1,4,5 338:2 340:4,4,8,9,22 341:1,16,17 342:2 342:8 343:11 344:18 345:5,7 347:17,21 348:2 348:18 349:1,17 349:19 350:16,19 354:7,17 355:6 356:16,17,22 357:2 393:10 radonuclide 275:13 Radon-222 315:2,3 321:18 Radon-226 310:17 raffinate 275:3 310:22 321:12 331:12 332:11 350:12 raffinates 277:14 277:14 310:11 354:8 raise 88:7 187:14 raised 111:19 132:6 197:1 raises 93:6 124:18 179:3 180:12 298:11 ramp 369:14 ramping 372:1 ran 232:7 random 193:18 207:18,21 213:16 213:21 Randomize 213:20 randomized 208:3 randomly 54:14,16 80:6,8,10,13,15 81:8 139:17 randomness 72:17 randoms 214:3 range 172:10 297:18 363:20 377:13,14 ranges 375:12 rapid 321:6	25:5 26:14 43:11 65:4,7 66:8 66:10 73:6 77:19 78:4,14,18 79:5 101:15 134:19 135:7 145:18 310:7 315:5,12 317:7 318:6,13,19 318:22 320:16,21 321:1,7 323:17 326:8 328:13,15 328:18 335:9 339:22 340:10 341:2,3,6 342:3,5 342:13 354:14,16 355:3,8,11,15 rated 356:2 rates 20:11 24:6,7 24:13 26:5,11 65:17 66:15 67:2 70:10 75:6,11 76:6 78:6 79:1,20 81:16 112:7 310:5 313:12,13 315:19 316:18 319:21,22 320:8 328:2 330:7 332:13 333:6 339:21 340:18 346:2,3,4 ratio 63:22 65:2 66:19 225:5 250:10 261:1 280:4 288:16 290:20 292:13 311:12,12 312:4 322:1,11,16 323:4 323:7 331:8,13 336:15 341:21 375:7 377:12 ration 289:9 rational 129:7 rationale 143:15 337:19 ratios 225:8,8 280:8 285:17 286:2 322:13 raw 41:19 90:13
---	---	----------	---	--

132:21 153:2	65:10 83:5 84:13	189:22 244:1	recommendation	reconstructors
253:13 258:17	84:18 90:14 91:22	246:7 251:14	231:12 234:13	94:16 176:11
263:16 266:20	98:12 108:5	252:22 268:21	368:4 415:6	214:14
267:2 270:13	116:11 129:21	275:13 278:16	recommendations	reconvene 117:15
391:21 392:9,13	137:20 167:20,22	321:21 384:10	368:6	199:12
392:15 393:3	171:6 179:17,22	389:15,15 391:13	reconstruct 19:10	reconvening
394:20 395:6,8,8	188:2 192:12	409:3,4	19:14 41:7 42:11	118:19
395:11 396:19,20	196:10 197:3,8	reasonable 21:9	53:20 80:18	record 40:7 46:14
410:6,19,22 411:4	203:9 206:13	101:3 125:10	102:19 122:20	49:1 88:3 118:14
411:17	225:6 227:22	148:13 213:14	129:21 155:17	149:6 173:10
Ray 2:13 7:17,20	231:8 242:15,16	254:6	169:15 185:19	183:2 184:3,8
127:8	245:9 254:7 259:5	reasonably 42:19	259:8 271:16	192:18 199:15
reach 35:1 207:15	271:4 272:20	58:22 340:2	272:3 294:4	214:15,16 222:11
reached 334:22	280:11 283:5,6,13	reasoning 263:17	298:17 306:6	240:19 303:19
reaction 198:6	287:4 290:18	reasons 189:14	348:2 350:11	376:21 381:6,21
reactor 232:15	292:3 295:22	190:16 242:4,5	359:1 371:12	384:4
268:4 336:22	299:9 307:9 308:9	268:22 270:6	385:15	recorded 184:12
reactors 325:7	308:11 313:21	305:6 359:8	reconstructed 17:4	237:13 363:5
read 14:21 44:15	323:8 326:1	reassessment	85:3 270:22	records 33:22 34:6
47:2 102:13 147:4	327:22 330:9	308:15	329:15 351:17	42:1,10 46:5,6
147:13 149:5	335:21 337:14	rebuttal 333:16	reconstructing	63:13 88:2 90:13
217:22 218:1,15	344:5,7 346:13	334:12	165:18	94:1,1,3,11 102:1
226:6 227:21	347:14 349:5	recalculate 383:15	reconstruction	102:3 107:15
240:19 312:20	353:10 354:1	383:16	37:17 38:6,16	149:3,15 150:19
313:1 314:13	358:21 361:8	recall 27:11 97:2	88:7 89:12 91:19	155:16,17 156:2
322:7 416:13	362:3,8,11,20	108:14 172:7	123:2 126:2	157:7 163:4
readable 218:16	363:1 364:13,20	309:21 326:19	155:12 156:21	164:12,13 169:16
reading 206:12,13	365:10,17 367:4	419:11	168:12,20 175:16	180:15 184:17,19
317:19,19 319:4,5	367:22 368:13,22	recap 40:20 359:11	175:19 177:18	185:9,12,14
319:10 321:7	369:13 371:12	receipt 244:7	178:9 182:12,20	190:22 195:3
343:17	372:13,14,14	receipts 224:10	186:13 193:20	196:10 222:15
readings 359:4	374:22 375:16	receive 59:12 94:17	197:14 210:1,2,3	282:5 306:10
ready 61:6 160:21	376:10,20 378:18	229:12	215:3,10 225:4	315:17 381:8
297:8	379:9 380:6 381:1	received 12:15	267:7 271:7,21	382:5 385:14
real 34:9 115:20	381:3,6 384:5	37:17,18 38:6,14	301:18 302:9	recovered 165:7
238:15 240:21	389:13,14 390:6,8	94:18 215:1 228:6	326:17,21 327:2,6	recovering 228:13
300:6 326:3 353:6	390:14 391:12	230:3 244:22	352:16 356:18	recovery 244:13
388:11 413:15	400:13 401:9	248:21 357:16	359:21 361:12	248:7,9,17
realistic 294:6	402:18,20 408:6	370:15	362:14 414:6	recreate 127:14
reality 291:6 325:7	408:16 412:11	recharacterize	reconstructions	145:1
400:19 401:10	413:4,7,10 415:12	404:14	30:15 84:5 91:10	recurring 29:11,13
realization 355:14	416:21	recognize 264:8	91:12,13 175:12	61:2
realize 49:19 332:2	reason 35:12 41:3	recognized 224:1	177:21 182:3,5	recycle 223:3
realized 355:9	42:4,5 52:9 56:17	recognizing 360:2	192:15 267:10	recycled 10:1 14:15
really 10:22 18:6	58:15 96:18	recognition 96:16	272:8	22:3,12,16 50:10
29:19 32:4 33:17	111:18 142:1	146:5 173:9	reconstructor	117:16 118:3,7
49:9 52:21 60:17	157:9 176:18	329:20	109:2	136:8 165:18,19

215:4 216:4 222:7 223:12,14,15,18 225:16 226:9 228:7,18,20 229:2 229:2,4,6,15 230:1,2,11,14,18 231:2,5,9,15,20 232:5,8,12,13,21 233:2,7,15 234:3 234:8,10 235:6,12 235:21 236:3,8,11 237:3,4,8,10 240:10 241:11 247:13 248:1 254:21 256:9,15 256:21 257:12,17 258:12 259:4 265:4 268:2,17 274:19,21 290:5 296:16 297:4 300:20,21 301:21 303:7 304:8	134:21 references 102:9 152:9 164:17 239:14 referring 148:22 217:14 250:3 refers 218:18 307:9 refine 105:14 refinery 71:21 370:8 refit 277:15 reflects 25:22 307:10 regard 197:18 202:6 317:1 332:8 404:21 regarding 22:16 50:10 51:1 137:16 147:6 192:20 196:19 197:6 272:21 280:11 314:4 325:9 328:2 regardless 110:5 124:11 347:19 regards 376:16 regress 185:15 regroup 154:20 regular 108:19,20 regulations 59:5 60:12 225:10 261:5 regulatory 59:16 59:18 60:13 reiterate 417:12 reiterated 357:13 rejection 213:17 relate 362:18 372:16 related 146:21 215:2 356:18,19 369:20 376:13 377:2,3 398:1 relation 370:3 relationships 280:6 relative 275:22 relatively 21:15 323:15	release 313:12,13 324:16 326:8 333:6 337:5 released 313:9 314:4 332:20 335:15 336:1,16 releases 304:18 306:20 308:8 relevant 195:19 275:11,21 393:2 reliable 162:21 325:5 relied 329:22 rely 42:2 260:8 333:1 366:1 remain 331:9 348:14 remaining 150:7 remains 187:17 331:17 345:10 357:5,6 remediating 127:18 remediation 127:13 368:8 remelted 232:11 remember 34:7 77:12 108:15 114:10 116:4 146:22 147:7,9,13 161:4 183:10 187:4 189:12 246:3 262:14,16 262:20 290:16 309:21 317:10 351:15 387:11 remembered 284:5 326:16 remembering 189:4 remind 8:21 229:9 260:22 265:11 347:20 reminding 352:12 removal 318:14 removed 341:8 removes 315:2	removing 315:13 320:11 renal 101:14,19,22 repeat 5:5 64:15 repeated 311:20 417:20,21 repeating 384:15 417:13 replication 316:3 report 10:11,14 11:2,3,8,9 13:3 14:2,5 19:1,2 22:17,19 26:20 38:1 41:19 46:13 46:19 68:14 79:1 92:13 115:16 117:22 118:21 121:22 133:3,13 133:16 135:6 136:18 149:20 164:18 174:14,16 174:17,18,18 176:10 215:1 216:5,11 220:18 224:6,8,8,11,19 226:8,21 227:1,12 227:15 229:3,6,12 229:13,14,22 230:8,16 231:18 235:1,3,5,5 236:1 236:3 238:18,20 239:10,12,22 240:1,4,5 241:2 243:10 245:3 247:19 249:11 253:10 255:22 256:8,9 257:2,19 257:21 258:1,4,6 258:11 260:6,9,9 260:13,14,17 262:4,8,11 264:19 265:1,5,12 266:22 269:14,15,16,21 283:18,19 284:3,6 285:2,11,19 299:16,22 300:14 302:6 306:8 307:9	307:13 308:4,10 308:11,13,17,22 309:3,4,7 310:13 313:10,19 314:7 314:12,14,15 316:1,3 322:12,21 324:10,15,21 326:14 329:2,8,10 334:3 354:13 368:20,21 369:4 369:17 370:14 371:4,19 374:6 392:21 393:7 397:5 401:5 410:3 415:4,20 416:1 reported 147:7 245:2 250:2 297:19 332:8 333:15 REPORTER 385:17 reporting 262:7 reports 11:19 184:10 216:15 222:2,3,4 224:1 227:9,10,16 242:6 242:15,17,17,18 253:8 262:15 263:1,18 265:9,9 265:17 266:12 360:12,16,20 361:1 362:21 364:12 366:20 367:4 368:12 371:7 372:17 376:1,6,22 381:13 382:8 389:12 395:14 403:10,10 405:4 406:19 415:22 represent 99:9 102:2 241:12 310:22 318:21 334:17 354:16 376:1 404:11 representation 26:9,10
--	---	--	---	---

representative 31:16 123:9	357:12,15	reverse 79:13	232:16,20 233:12	92:18 94:6,7 95:5
represented 62:8 234:16	respond 226:19 276:17 347:2	review 15:19 86:13 121:22 132:20	234:12,21 235:10 235:13,18,22	100:14 101:9,16 105:19 106:9
representing 334:18 394:15	responded 115:1	135:1 136:1,13,18 149:1 151:8	236:9,14,17,20 237:3,7 238:12	110:9 116:17 126:11,12 127:12
represents 280:9 360:15	response 4:11 5:16 8:18 74:14 220:4	152:19 155:20 165:4 170:1	239:1,3,7,11,19 240:2,5,8,12,15	129:12 130:2 131:9 134:2
reprocess 244:12	220:14,17,21 221:5,8 231:16	178:11,20 183:16 197:2 211:15	240:20 242:9 243:8 247:7,11	137:18 138:20 139:3,10,22
reprocessed 248:6	238:3 296:5 336:22 347:5	215:2,7 220:1,5 222:6 226:1	249:1 250:18,22 251:6,21 252:2	140:11,18 142:13 143:8 146:19
reprocessing 248:12 276:4	responses 115:12 115:13	233:18,22 240:9 295:21 296:19	253:18 254:5,18 255:6,10,13,19,22	148:18 151:11 152:4,4,17 153:2
reproduced 217:16 226:22 227:7 266:11	responsibility 255:14,16	302:19,21 303:10 304:7 307:12,14	256:5,12 257:1,18 258:1,10,18	153:15,22 154:6 154:19 157:12,20
request 149:19 294:10	responsible 299:3	307:20 308:19 324:20 326:14,21	260:16,20 261:18 262:1,6,10,19	158:3,14 160:2,7 162:6,16 165:6
requested 405:9	responsive 353:4	327:17 330:12 346:22 347:2	263:2,5,20 264:12 264:21 265:11,21	167:1,13 168:21 170:11,11,18
require 408:8	rest 212:19 244:17 244:19 377:3	356:12 360:18 361:9 364:11,11	266:4,13 269:19 276:17,20 279:16	172:3 173:14 175:20 176:3,21
required 59:4 93:16 225:10	restricted 60:13	377:19 390:10 403:4 412:1	281:17 282:7 283:17 284:17	177:19,22 178:1 179:11 183:10
requirement 268:6	result 44:6 54:19 74:1 105:11 150:9	419:19 420:17,19 420:21	285:3 286:12 287:5,11,15 288:2	185:3 186:6 187:3 187:4 189:4 190:9
requirements 90:22 115:6	result 44:6 54:19 74:1 105:11 150:9	reviewed 46:15 169:12 170:4	288:13 289:7,11 290:6 292:19	191:17,21 193:11 196:14 197:22
requires 197:3	resulted 36:7 327:10	183:3,13 184:2 195:21 222:2	293:3,10,18 294:18 295:2	198:20 203:5,21 206:4,7 207:11
resample 145:1 148:15	results 32:18 107:2 140:10 149:22	305:7 327:1 346:9	302:2,5 303:5	210:11,16,18 211:6,14 212:15
research 134:14 152:2 153:10,19 165:7	150:3,14 153:8 165:12,14,17	reviewing 14:12 102:15,16 133:8	Richard 222:15	213:5 214:1,6,15 215:9 218:9
resend 217:1	169:2 269:17 283:1 284:10	135:5 206:2 376:19	rid 419:10	219:16 226:20 230:10 231:7
resident 338:2	315:18 380:6 385:8 397:17	reviews 178:9 190:5	Ridge 223:8 299:22	237:15 240:12 254:18 259:15,15
residue 250:20	resumed 40:8 118:15 199:16	revised 308:3	right 10:15,18,22	260:19 261:19 264:6 268:20
resolution 69:16 77:13 102:12 379:1	303:20	re-evaluating 259:2	11:4 14:13,19 15:16 24:2,4	270:4 274:6,14 282:8 284:20,20
resolve 117:6 233:13 356:10	retention 335:18 336:4	rich 2:4 5:2,2,6,6,7 5:8 27:5 40:15	25:19 31:5 35:4 36:18,20 39:21	287:10,20 291:6 293:20 302:16,17
resolved 388:19	retorts 364:18	219:18,19,21 220:3,8,12 221:15	46:1,1,19,19 49:6 49:6 51:11,19	302:20 303:9,13 303:14 305:8
resolving 362:8	return 188:3	222:19,22 226:15 226:17,19 227:8	55:22 56:10 61:17 61:19 64:13 67:21	310:20 316:22 343:10,12 347:19
resort 30:21	returned 199:21	228:15 229:1 230:4,10 231:12	67:22 68:1 70:20 73:1 79:6,16 80:2	
resources 97:16 98:14 141:4	returns 13:5		81:9 85:10,16 87:2 88:16,20	
respect 296:16 327:18 330:10	reused 232:11		90:13,19 91:20	
respiratory 247:6 291:11 349:14	revealed 172:16			

352:7 353:20	144:14,18 148:20	RT 318:5	146:22 148:7,13	382:20 383:2
383:19 388:10	150:18 151:2,7,10	RTS 314:19,19,21	152:12 160:5	384:19 385:7
393:20 394:1,5	151:16 152:1,5,14	318:20 319:4,10	161:18 166:21	386:16 389:11,20
395:19,19 400:3	152:18 153:13,17	319:12,15 320:2	179:10 180:9	390:6 391:10,11
401:7,12 404:15	154:7,18 164:7	320:12 328:17	185:9,22 186:5	392:3 394:18
404:20 407:5	165:3,9 174:11	332:14 339:21	188:20 189:18	395:9,15 398:19
415:7 416:16	175:2,8,15 176:3	340:7,11 341:3	193:18 212:4	sampling 9:22
418:14	186:17 221:7	346:4 354:15,20	213:1,16 243:17	10:10 11:14 14:15
right-hand 51:16	246:18 259:1,15	355:2,9,16	243:21 286:19,20	16:2,5,10,10
rigor 191:2	259:20 267:5	RU 10:10 214:21	297:22 363:20	17:14,19 18:16
rigorously 283:8	268:20 270:17	222:1,16 257:4	364:12 373:8	26:21 31:1 33:9
ring 290:21	273:2 277:4 298:9	rudimentary	384:5 385:1 393:7	43:20 44:2,5
rise 331:18	298:16 300:10	111:10	394:2 396:7	53:15 54:3,14
rises 23:12	338:20 339:10,14	rule 30:13	sampled 54:14	61:10 72:9 74:2,7
River 224:14	348:1,16 349:2	run 20:18 122:6,12	56:17 101:6 138:3	83:2 84:12 104:15
RMI 262:11	357:10 392:18	122:17 248:14,16	151:19 152:10,16	131:11,19 137:10
road 415:10	393:1,5,17,21	334:5 340:6 355:2	158:22 159:12	139:6,14 141:9
Robert 1:21 2:3 4:3	395:5,12 396:9,13	378:15 380:7	162:13 166:3	143:13 144:13
4:18	397:3,8 405:12	running 161:22	171:14 175:9	146:21 149:13,15
robust 30:22 32:9	410:1,15,19	244:11 347:6	178:3 181:1 264:5	155:15 158:12
45:1 108:13	411:11,15 412:4	ruthenium 279:22	282:20 285:6,8	159:8 160:11,18
137:21 204:2	412:10,15 415:14	281:10	314:16	161:15 162:8
390:5 413:12	416:1,4,9,17,20		samples 18:5 26:1	171:11 178:22
robustness 385:1	417:1,4,7,10,17	S	27:22 28:3 44:10	184:19 191:8
Rocky 39:19 43:8	417:19 418:2,6	S 3:1 19:21 20:6,11	48:3 49:10 50:15	195:5,6 200:4
155:6,9,14,20	419:2,11,15,21	377:10,15	51:6,17,21 52:18	213:17 264:3
159:6,11,18 160:3	420:4	safe 103:1	53:2 55:15 56:8	288:5 306:5
163:13 171:19	roll 3:14	SAFETY 1:8	56:22 57:2,5,10	310:18 312:6
172:3,8 181:13	rolled 24:18 49:19	sake 139:16 314:8	58:4,7,13 61:3	360:4,21 362:13
189:12 190:4	49:20 61:22 62:1	316:5 324:8	64:6,7,7 66:1,6	367:12 369:18
202:10	68:10	Sam 305:5 324:21	71:22 77:11,18	370:6 390:21
Rolfes 2:2 4:16,16	rolling 27:20	324:22 333:15	79:13 99:3,9	393:11 394:20
25:9,11 37:13	370:22	334:3,9,20 335:12	100:12 114:12	Sandra 2:15 8:5,7
38:3 56:4,6,11	roll-up 56:21 76:3	337:11	125:15 128:8,9	12:13,14 98:22
60:14 70:16,21	room 1:15 3:15	sample 18:5,7,8,9,9	138:22 139:2,18	99:15,16,17 102:6
74:21 88:20 89:3	4:12 5:18 7:3,15	18:12 34:18 35:11	139:19 140:16	380:8,11
89:5 90:15,20	9:8 13:15 41:1	42:12 44:21,22	156:12 157:15	satisfactorily 178:4
91:4,8 92:7,18	289:6 374:20	45:15 52:9 54:16	158:6,9 179:20	satisfied 251:7
93:3 94:14 102:5	rooms 365:4	60:7 76:21 77:17	184:4 185:1	Savannah 224:14
104:21 106:18	roughly 34:1 38:10	80:6 81:14 84:13	188:18 191:15,16	saw 145:22 146:2
110:19 112:4	338:5,17 360:12	99:21 100:3,7,8	201:7 204:1,1	171:20 255:2
114:21 116:18	416:9	100:16 103:19	237:20 288:14	297:3 323:11
122:21 123:14,21	round 377:14	104:21 105:1,5	300:1 323:1,12	saying 33:16 34:16
125:17 126:9,15	route 122:12	106:12,13 113:18	358:18 363:8,10	35:10 36:15,19
128:12,19 130:2	routinely 186:20	123:8 138:10,14	363:18 365:1	37:14 40:2 44:15
134:3,8,12,15	rows 249:19 310:19	139:18 140:8,16	373:7,11,16,18	55:12,18 62:14
135:3 143:16	Roy 2:12 7:8,10	144:5 145:4	374:7 375:4,11,16	65:20,22 66:4

83:7 85:17 98:16 98:17,18 102:21 110:4,17 128:17 157:17 158:2 166:19 176:13 181:8 182:1 183:8 186:2 189:16,17 193:9 194:4 196:21 202:6 203:9 207:11 209:5 212:8 229:5 230:15 236:13 243:2 249:3 251:4 251:7 265:15 269:12 272:20 279:13 284:13 292:16 293:22 331:10 332:19 334:1,9 337:17 340:16 342:10 351:21 352:1 353:16 354:18 355:19 386:14 392:9 396:15	scenarios 272:15 273:10 Schofield 1:22 4:5 4:6 144:1 301:5 Science 328:22 Sciences 326:20 327:1,16 346:10 scientific 322:4 347:15 scientifically 327:7 scientist 330:11 scrap 232:9 236:21 screaming 343:9 screen 18:22 218:16 309:1 313:1 352:20 SC&A 2:5,6,6,7,8,8 2:9,9,10 5:18,19 6:6,10,11,14,19 6:22 9:22 10:4 12:20 16:9 23:13 27:9 74:11 84:11 111:13 112:13 115:10 119:16 120:8 121:22 132:20 133:8 134:1 135:5 145:19 174:2 196:18 198:14 200:4 212:4 235:3 260:12 270:11 274:1 285:11 303:3 304:7 306:21 308:2 347:2 352:3 356:2 356:20 390:16 412:16 419:19 420:17 SC&A's 178:20 215:2 219:22 239:14 se 158:8 229:4 seal 316:15 320:7 345:8 sealed 245:7 309:17 342:9 353:12	sealing 353:19 search 89:9 211:10 Searches 315:17 searching 113:20 164:7 seat 143:21 SEC 7:15 60:15,17 92:13 122:5,14 125:21 126:6 127:1 129:3,20 157:10 208:7 307:12 326:7 346:7 348:14 356:3,11,12 404:1 second 125:13 148:21 185:4 219:7 257:5 269:10 277:7 278:21 310:20 316:9 332:7 360:11 369:13 387:11 390:16 415:4 secondary 197:16 233:19 seconds 318:1 secretary 106:11 section 135:1 230:5 230:11 235:13 238:13 256:14,17 256:20 312:19 314:10 368:4 sections 335:13 367:8 security 34:15 58:1 86:18 187:5,7 see 19:7 24:8 26:4 30:8 32:8 35:12 38:5,20 51:19 53:13 54:6,16 56:3 58:5,10 59:3 60:5 63:2 64:21 66:1 72:1 76:4 77:2 80:19 82:22 83:2,9 85:3,10 93:5,7 94:10 95:17 103:20	104:9 106:9 109:12 110:6,13 112:21 117:20 123:12 141:7 142:21 144:20 145:21 146:16 147:4,5 148:10,10 151:17 156:9,16 177:14 179:4 199:11 200:15,17 201:14 203:18,19 205:5 209:19 210:4 212:12 217:13 219:1 224:9 227:15,21 228:3,6,8 236:12 239:19 241:4 247:15 249:18 250:8 258:4,14 286:7 288:13 296:3,3 297:10 299:13 300:17 301:19 310:19,21 311:9,16 312:4 314:6 316:5,19 317:1,3,4 319:5 320:20 321:1,6 322:5,10,12,15 335:12 342:11,14 346:1 353:13 354:9 360:13 369:12 372:4 374:22 375:3,9,22 376:17 379:20 381:11 383:22 386:6 388:5 389:8 397:9 399:3,5 405:13,18,19 411:12 412:17 415:20 416:11 418:14 seeing 97:3 249:22 348:21 354:3 seen 97:13 132:17 266:9 299:1 segue 381:5 select 139:17	159:15 selected 150:8 153:16 280:8 404:10 selective 159:8 359:22 360:21 selectively 75:1 110:22 self 8:3 self-identify 7:16 send 11:18 217:2,3 218:14 228:19 230:8 261:20 410:5 418:20 sending 296:4 315:8 sense 22:21 61:9 75:22 88:12 107:9 109:5,12 113:8 137:9 138:2 140:22 161:18 174:9 175:12,14 180:5 206:21 237:4 256:21 291:9 303:7 344:5 344:7,16,16,22 414:21 sent 10:5 16:3 46:21 115:9 228:19 237:1 244:17 253:16 261:13 268:4 289:16 370:17,21 sentence 219:11 257:6 separate 22:17 112:10 205:19 264:9 277:9 292:4 350:22 390:14 391:19 395:15 separated 276:6,9 278:7 279:15 separately 28:12 251:18 separation 276:22 277:1,16 278:18 separations 280:19
--	---	---	--	--

281:3	408:19	showing 46:16	353:11	226:10 234:3
sequence 387:4	shifted 45:2 282:14	172:13 353:17	similar 130:20	255:16 262:12
series 265:4 310:19	ship 282:9	shown 241:18	155:9 161:17	268:5,13
315:1 317:12	shipment 233:20	359:4	162:15 174:19	sitting 87:10
363:9	255:4 261:4,10	shows 53:10 62:19	340:12 371:6	187:18 193:9
serious 122:19	299:21	75:14 89:1 157:13	372:22 377:16	284:4 342:7
320:6	shipments 224:12	222:6 226:8	403:12	situation 39:19
seriously 265:10	226:13 227:17	227:12,20 286:18	similarity 301:13	108:11 189:7
serve 345:22	228:10,15 229:4,7	370:15 375:7	simple 165:21	291:7 365:7
served 266:22	230:2,3,13 235:20	side 20:21 41:13,17	231:21	387:21 403:1
SERVICES 1:3	244:22 254:14	52:20 59:9 87:10	simplicity 316:5	situations 386:10
set 46:12 71:4,5	257:4 265:19	297:21 298:1	simply 63:22 74:4	six 9:2 21:13 86:21
78:13 211:5,9	276:15 293:15	316:22 321:2	74:14 148:5	162:13 169:3
219:14 222:1	299:9 300:3	348:12 352:2,8	193:21 233:1,14	173:21 196:4
223:4 242:14	shipped 222:11	386:8,17 401:9	244:17 313:16	305:14,15 311:21
245:1 246:19	225:14 228:4	sideline 109:12	318:3	312:16 329:6
270:7,13 276:13	237:18 268:12	sides 112:10	simulates 345:3	357:3 366:6
280:10 312:8	281:7,19 293:6	significance 172:1	Simultaneous	380:14,16 384:8
337:1 360:21	shipper 262:16	significant 29:19	213:3 255:5	405:11 407:18
361:19 362:18	265:22	52:7 150:10	single 183:20	417:4
382:1 390:14	shipper's 265:13	169:11 259:6	215:19 233:1	sixteen 373:15,19
391:11,19 392:4	shipping 224:13,18	271:5 273:4	256:16 323:2,3	374:2
397:12,14 398:2,4	225:9 227:2,9	333:10 348:22	373:8 395:7	Sixteenth 399:22
398:20 404:11	237:16 255:16,20	357:11	singles 41:10	sixties 274:20
406:2,4 413:12	263:7 299:2	significantly	sir 48:1 51:11	317:9
sets 50:4 95:16	ships 254:21	323:17 324:15	385:17	six-inch 336:11
312:7	Shonka 282:11	signing 114:16	sit 115:21 210:14	size 138:10,14
settled 244:1	short 118:19 130:1	signing 114:16	site 7:18 30:8 37:20	186:4 189:18
settling 277:2	192:21 244:11	Sill 322:6	43:3 58:12 60:18	248:16 325:10
seven 3:10 21:13	294:8 311:6	silly 288:19	60:19 113:3 126:4	370:7 385:1
84:20 224:10	364:16 379:7,16	silos 309:15 311:7	152:2 153:10,19	sized 379:9
227:1 310:14	393:18	311:15 312:3	155:9 162:9 165:7	sizes 166:21
377:18	shortly 11:4	314:16,21 315:5	186:18 188:21,22	skip 117:18 211:19
seventies 254:13	short-lived 340:4,8	315:19 317:13	209:1,7,7 216:2	317:13
274:21	340:17	318:6,9,16 319:1	226:1 232:22	slab 345:17
seventy 317:9	show 23:16 34:22	335:18 342:16,18	233:9 245:14	slurry 278:6,7,8
shaded 64:22 80:12	50:19 54:15 76:17	344:17 350:13,19	254:20 265:18	slushing 202:3
shading 376:6	102:3 175:21	353:18 354:17	274:18 299:2	small 21:15 31:18
shapes 371:1	176:9 177:10	silos 10:1,14 304:18	308:8 312:19	36:10 103:20
share 142:4 247:8	184:10 218:6	305:2 306:21	313:3 348:4,13	107:9 114:12,19
375:1	260:14 337:12	307:16 309:5,10	350:20 351:7	139:11 160:5
shed 232:3 345:2	376:9 380:21	309:20 310:5	352:1,4,6 356:2	162:19 164:2
sheet 412:18	389:12 403:18	313:5,9,15 314:22	356:22 370:22	165:21 172:4
sheets 149:18 396:1	414:2	315:4,7,9,10	371:1 377:18	213:16 226:12
408:9 413:6	showed 26:6 80:12	320:7 321:5,10	383:6 389:17	227:3 270:18
she'll 10:19	190:4 248:13	323:13 324:5,17	sites 59:22 97:13	273:8 290:1
shift 361:21 408:17	389:18 411:2	330:20 343:6	224:4,13,20 225:9	296:12 349:8
		347:22 349:3,20		

smaller 379:10	213:17 267:6	speakers 213:3	spreadsheet 94:21	215:17 226:10
smallest 345:9	275:3 276:13	255:5	110:21 133:18	227:2 228:12,12
snapshot 57:20	283:11 284:4,11	speaking 9:1 98:22	206:1 361:17	231:3 237:16
201:13 362:4	289:17 292:11	250:5 256:3	372:7 383:17	275:2 277:13
372:3 414:14	311:3 337:4	speaks 257:22	392:15 395:7	278:1 330:18
social 34:15 58:1	349:18 394:8	special 126:1 143:1	396:14 410:4,8	359:3 379:17
sole 349:3	396:1 402:20	248:18 249:4	415:13,15,21	404:4 417:11
solely 271:6	419:9	251:16 254:8	spreadsheets 97:1	starting 3:16 36:18
solid 39:4 298:12	sorted 95:6,8 139:8	270:8 273:21	151:13 164:20,22	36:22 57:13 59:2
solubility 103:6	396:3	284:14,15 291:1,2	359:18 361:2,3	62:21 157:13
197:12	sorting 63:10 72:3	291:3,7,10	373:5 382:7 397:2	172:18 216:6
soluble 103:3	95:9	specially 269:8	410:7,12 412:6	226:5 289:2,3
solution 122:8	sound 213:13	specific 17:2	SRDB 239:5	304:2 321:16,17
solve 344:2	241:12 327:8	216:14 231:17	SSNs 111:15	323:9 329:18,22
solvent 379:13	381:9	237:19 246:21	stack 53:22 286:5,6	331:19
somebody 51:7	sounds 43:2 143:4	264:17 282:16	286:17	starts 230:12
209:20 388:1	146:19 214:20	307:1 348:6,8	stacks 286:8,9	250:13
413:18	238:3 291:1,18	366:15 367:19	staff 8:17	stated 285:16 313:4
somebody's 328:20	351:22 414:22	374:11,12	stage 14:16	354:8 420:16
someone's 165:18	415:7	specifically 133:8	stand 117:21 242:6	statement 43:21
271:17,22	source 137:1 219:5	161:2 169:17	standard 20:13	44:11 73:15
something's 344:11	325:6,19 341:9	229:18 233:4	25:20,21 28:1	137:16 139:15
somewhat 67:2,3	349:3 383:12	244:21 266:21	29:16 104:17	226:11 234:18
70:11 79:21 212:8	399:6	302:9 350:12	143:11 243:19	354:12 355:1
312:7 327:12	sources 267:16,20	388:10	standpoint 124:14	statements 58:8
soon 13:4 228:12	271:8,15 305:1	specification 244:8	286:13 302:12	225:12 315:16
245:11	so-called 22:12	283:8 320:12	stands 43:12 362:5	317:1
sooner 344:12	28:16	specifications	star 9:2	states 1:1 313:3
sophisticated 344:8	space 310:4,8 314:1	223:5,7 261:13	start 14:14 15:15	371:21
sorry 3:9 5:4 8:13	315:4,12 318:16	281:5,13,18,19	15:16 16:1 18:19	statistical 73:15
40:22 50:6 57:11	319:17 320:4,13	283:12 299:4	20:8 33:16 36:21	137:16 139:15
61:15 64:6,14	321:13 326:2	318:2	50:12 61:8 63:10	149:14 167:3
88:8 138:13	328:11 332:6,12	specificity 144:6	66:21 72:12 73:16	172:1 243:13
194:20 357:21	332:20 333:10	365:22	108:13 130:9,20	251:8 252:4
373:14 392:14	335:1,3,16,19,20	specified 47:4	137:21 138:12	statistically 73:10
sort 15:6,9 18:18	336:7 337:5 338:3	specs 279:2	140:9 148:18	statistician 148:12
24:21 27:10 29:17	341:2,8 342:8	spectrometer	154:2 156:16	statisticians 143:6
43:15,17 77:2	343:11 345:22	282:13,15	172:14 193:6	statistician's 138:4
78:21 86:19 90:10	354:3 355:7	speeds 336:3	200:12 226:7	statistics 187:20
93:19 95:14	sparse 387:21	spelling 147:8,9	237:16 256:14	363:21 391:2
104:17 108:22	speak 3:17 6:1	spend 57:14 172:6	303:15 317:21,22	397:15
112:2 120:4,16	13:20 14:1 21:19	225:13	334:21 367:9	status 306:13
132:19 136:12	72:5 116:20 117:1	spent 102:14	369:13 398:17	362:19
140:13 144:6	117:8 124:15	374:20	started 27:9,10	stay 14:7 61:19
177:4,12 181:4,16	184:16 221:11	split 187:14	28:19,19 60:2	67:5 131:18
181:18 189:21	258:2 340:14	spread 384:21	66:12 75:22 128:3	208:16
190:6,10 208:13	speaker 398:11	401:14 402:4	206:18 212:9	stayed 103:9

127:17 342:2	289:1	study 135:16 136:9	substance 135:18	152:15 153:6
stays 102:22	stop 63:16 127:22	149:9,21 150:4,6	334:12	164:18 174:14
103:16	384:1 404:20	150:11 151:22	substantial 222:10	227:17 235:20
steered 182:16	stopped 318:9	153:7 168:9 195:2	361:4	247:13 256:6
step 39:9,10 74:18	379:16	224:5 350:16	substantially 62:6	309:4 311:21
113:7 120:12	storage 309:5	351:2,2,16 368:4	66:15,18 81:18	333:14 367:11,15
161:17 185:13	313:6	368:21 369:11	250:12	summation 375:4
214:20 221:19	stored 277:13	stuff 112:18 132:15	substantive 147:12	summed 381:17
223:1 244:9	story 57:7,16 121:2	190:3 208:19	subtask 363:11	super 210:10,10
399:11 413:2,3	121:6 193:4	209:1 225:21	sub-action 386:2	superceded 258:6
414:1,16 415:12	280:14 335:2	229:10 263:8	sub-issues 376:18	260:6,9
stepping 43:17	346:13	264:14 278:20	sub-slab 345:11	supervisor 98:16
stepwise 97:14	straight 230:20	290:1 297:17	successful 111:13	supplement 397:13
stick 61:18 415:4	straightforward	298:21 350:17,19	sucked 248:5	399:8
stirred 336:8	148:17 347:5	sub 206:13 382:3	sudden 131:18	supplemental
Stiver 2:8 6:11,11	strap 243:22	subcommittee	353:12	376:11
216:22 305:12,14	248:22 249:7,7	352:16	suddenly 205:7	supplementing
312:16 346:17	250:4,6,13 251:14	subcontractor	suffered 345:6	391:16
357:22 366:13,18	251:15 252:5	150:2	sufficient 24:21	supplied 322:4
371:16 373:15,19	253:8 264:18	subdividing 31:12	128:14 148:2	supply 274:13
373:22 374:5,13	269:1,3,6,17	subgroup 53:6,8	155:17 156:20	support 181:3
374:17 379:6,12	290:19,20 291:8	66:14	166:4 175:18	308:3 312:1
379:18 380:4,10	300:16	subgroups 52:6	176:19 185:18	324:12 384:7
380:15,19 382:21	strata 63:20 64:1	247:14	199:3 231:13	supporting 151:11
383:4,8,12,19	strategy 18:7 35:5	subject 22:17 333:8	358:22	suppose 122:3
384:3 385:19	stratified 139:18	388:7	sufficiently 101:19	159:15 288:20
386:13 387:12,18	stratum 312:9	subjective 112:22	337:1 385:16	supposed 179:7
388:14,18 389:5,8	stream 264:9 278:7	113:5	suggest 32:13,14	186:9 350:10
392:17 394:19	300:18 301:9	subjectiveness	109:9 198:4 212:7	394:15
395:20 396:3	streams 243:21	120:15	214:12 341:5	supposition 360:7
397:6,9,21 398:4	244:4,5 247:20	subjects 15:2 279:9	413:10	sure 10:6 13:2 14:2
398:16 399:1	248:6,12 252:3,8	279:19 304:17	suggested 97:1	14:7 15:1,13,19
400:7,17 402:15	252:13 254:8	305:17	107:9	25:1 31:8 42:9,13
402:17 405:1,8,13	287:18 298:6,14	submit 137:15	suggesting 142:2	44:19 52:11 69:4
405:19 406:4,9,13	300:19,21 301:1,3	296:20	suggestion 144:7	70:4 77:5 87:16
406:19 407:3,6,14	strengths 55:20	submitted 161:10	380:2	105:20 108:20
407:18 408:4,19	stretch 346:15	188:7	sulfate 315:1	109:15,16 111:7
409:1,13,21	strike 190:12	subpopulation	sum 363:15 364:3	113:5 117:9
410:11,17 411:3,7	striking 367:4	31:19 47:8	375:3	120:14 123:15
412:7,21 413:3,14	strip 52:18	subpopulations	summarize 324:3	128:19,21 131:17
413:19 414:7,13	strontium-90	31:13 32:6 81:15	summarized 259:3	140:6 145:11
415:11,18 416:5	281:22	124:10	315:20 322:20	154:5,18 158:1
416:15,18,21	structure 373:1	subsampling	391:5	178:15,21 184:18
417:2,5,8,15,18	377:20	136:20	summarizes 368:13	186:14,15 187:19
417:21 418:4,13	structured 49:13	subsequent 48:13	summarizing 285:8	191:3 194:2 198:7
420:20	studies 194:17	120:2	404:3	198:13 208:6,11
stock 244:19 246:3	351:2	subset 113:21	summary 149:6,20	209:11 211:12

212:18 213:18	176:8	378:6 380:22	316:13,14 322:8	389:14 390:3
218:7 220:7	systemic 103:12	381:1,11 382:3	323:12 358:5,19	394:3,3,16 396:2
225:19 267:3	155:22,22 156:17	389:18 390:13,13	363:11,18 368:21	396:4
276:19 284:1	179:4 181:15	397:10 405:2,19	388:16 390:6	tasked 115:2 133:6
294:3 297:21	systemically 156:1	406:1 408:10,11	395:15	133:8,11 175:3
300:10 302:4	176:1	410:2 413:6 415:6	talk 20:22 31:21	412:12
312:5,7 329:22	systems 42:21	415:19	45:15 54:11 61:9	tasking 141:3
348:14 353:2	277:3	tables 19:17 26:6	109:11 117:19	tasks 363:13,14,19
355:18 377:11	T	56:20 68:1 80:11	137:14 146:9	368:14 374:1,2
382:18 389:7	T 325:10	164:17 227:6	198:18 199:1	383:1
391:20 410:9	tab 78:21 133:17	235:16 243:16	200:18 217:9	TBD 349:21 384:19
419:15	table 16:9 19:7,8	367:14 390:12	220:11 221:4,6	TBDs 197:2
surety 233:17	19:18 20:4,5,6,15	tabling 192:11	230:12 310:12	TBT 277:16
surface 318:9	24:7,8,8,11,22	tail 212:17 244:12	343:1 351:11	team 4:13,19,21
surfaced 131:22	26:3 27:3,13	tailing 371:22	362:22 389:9	5:1,2,8,12,15
surfaces 341:22	32:10 33:2 49:13	tailings 322:9,11,20	talked 15:8 99:19	149:17 266:16,22
377:14	49:18 50:19 62:21	322:22 323:4	173:18 184:15	392:20
surprise 71:19	63:1 66:20 68:14	tails 245:7,14,20	200:10 246:7	tear-down 127:18
73:12	75:12 87:11 92:14	263:21 289:13	266:20 320:20	technetium 22:8
surprised 76:11	114:6 128:20	take 12:8 26:3	384:3 400:20	237:14 243:12
surprises 54:17	132:13 139:21	35:11 38:20 47:20	talking 10:2 30:10	279:21
surprising 70:15	164:9 166:20	86:20 94:17 95:2	34:13,13 35:6	technetium-99
72:7 73:10 107:3	167:9 183:19	104:3 106:21	42:17 45:8,9,11	215:13
surrogate 255:3	191:19 193:1	117:12 142:7	48:4 55:21 93:2	technical 86:8
265:17 285:22	200:12,20 206:5,9	146:19 148:20	99:2 101:18 133:6	130:9 131:1
299:17 300:5,7	206:18 210:7	163:22 165:13	135:1 138:16	162:10 176:18
301:10	217:9,16,21	166:19 170:9	142:16 163:15	271:14 283:20
survey 405:16	218:18,21 219:3,4	180:19 211:16	167:6 170:8 171:9	318:2 337:16,21
suspect 53:9 97:6	221:20 224:9	244:18 249:8,8	171:11 174:22	338:21 339:6
285:12 341:14	226:22 227:17	268:1 284:2	180:18 192:13	350:15 386:19
switched 282:12	228:6 229:1,22	286:13 290:3	198:3 205:13	technically 60:19
system 88:22 93:2	235:4,8,17,20	302:16 303:12	229:16 234:5	technique 104:16
104:4 119:11	236:7 239:22	335:21 337:1	239:19 256:22	243:22 264:4
176:10,13 234:6	241:1 247:12,18	343:16,18 345:13	273:5,8,11 280:17	techniques 245:10
237:12 252:11	249:19,20 264:8	346:6 348:18	306:11 331:20	252:6 369:1
277:6,7,8 278:2,5	268:16 280:13	353:6 358:14	343:4 347:16	technology 277:18
309:22 310:2	284:5 309:3,14	372:5,8 379:22	394:14,18,19	277:22 278:10
314:18,22 315:6	310:13,17 311:21	383:17 387:13	395:1	Ted 3:6 8:10 40:9
315:11 317:22	311:22 312:11,13	388:13 399:11	talks 78:20	142:8 199:19
318:5 319:12	315:20,21 316:3,7	405:15 410:5,7	tanks 228:14 278:6	214:17 303:22
320:2 328:4,10	319:2 330:4 344:6	411:21 414:8	target 357:11	telephone 118:10
332:14 340:22	351:14 352:11	415:18 418:6	targeting 45:16	tell 40:14 57:15
343:12 346:4	358:14 359:9	taken 54:13 66:6	task 135:5,12	62:22 72:5 83:5
354:20 355:10,16	360:13 367:15,18	126:13 183:21	137:19 153:22	197:8,10,11 287:6
systematic 172:12	372:7,7,14 373:1	238:11 251:17	172:6 364:2	292:18 328:5,14
403:4	376:9,16 377:18	254:15 288:15	365:10 373:9	343:21 390:9
systematically		293:14 310:10	374:4 382:6,22	392:6 418:21

419:22	7:11 12:18 25:13	324:20 341:10	135:5,12,22	329:17,18 330:8
telling 112:2 329:2	52:1 65:19 96:7	394:10 403:9	140:12 141:2	330:11 334:2,7
tells 83:2 328:19	155:1 170:13	408:16 418:19	143:10,16 144:14	335:5,6 338:11
396:7	199:6,13 234:18	things 3:11 8:20	144:16 145:18,22	339:9 348:11
temperature	240:20 402:16	13:17 15:7,8	147:17 148:2,14	350:10,17 352:3
245:18 325:3	421:6	26:19 27:17 28:18	152:7,13,14	356:5 357:13
336:2	thanks 138:12	29:17 46:4 61:11	153:21 154:12	371:7,12 376:7
temperature-dri...	151:9 194:22	67:1 72:9 74:13	155:6,19 156:15	380:1,2,20 381:17
337:2	195:13 237:22	76:16 84:3 97:17	158:7,20 159:3	384:1,14 387:2
ten 13:9 21:14	240:7,14 398:15	115:1,3 117:3	161:2,16,18 162:4	388:21 389:11
40:15,17 71:7	theme 29:11,13	126:13 128:20	162:14,20 163:8	390:8 393:12
118:11 156:12	61:2	141:5,6 156:17	167:5,14 168:7,9	394:7,17 398:5
169:4 191:8	THEODORE 1:23	181:9 184:14	171:5,20,22 172:9	400:2 402:14,22
tend 105:21 336:6	theoretically 123:9	187:14 197:12	173:14,15,15,18	403:8,9 404:2
346:10	theory 29:1 203:8	209:18 210:4,6,8	174:2,20,21 176:7	405:4 406:6
tended 112:1	407:21	210:9 242:12	177:17 178:8,15	412:10,13,15
tends 52:19 295:13	thermal-hydraulic	270:12 295:9	179:15,16,18	413:4 417:22
312:1	336:21	297:22 298:20	180:17 182:15	418:16 419:2
tension 160:19	thermal-hydraul...	308:20 311:5	184:21 185:6,19	420:7
ten-minute 117:12	336:20	345:21 354:9	185:21,22 186:1,3	thinking 29:10
term 196:7 289:19	they'd 165:6	361:15 362:21	186:17,22 187:18	99:17 111:9
294:10 325:19	236:22	388:15 392:11	187:21 188:13,17	138:21 139:4
341:9	thin 146:15	406:17 408:6	188:20 191:5	173:9 208:6
terms 16:12,15	thing 19:1 51:4	414:3 418:21	193:22 194:2,5,9	292:17 403:17
24:13 26:22 50:7	55:20 66:2 71:2	think 8:21 11:10	194:11,13 195:9	third 167:6 277:15
71:11,15 78:6	76:18 83:1,3	15:14 23:2,22	196:13 198:5,10	278:4,11 410:12
107:4 136:19	86:19 108:22	28:20 32:3,19	199:3 202:8,10	410:13 411:13
138:22 167:20	110:16 112:5	33:7 36:3 39:11	204:17 205:12,13	412:8 415:13,14
168:3 173:19	113:10 116:3	42:7 43:9 45:6,7	205:15 207:13,17	415:21
177:11 189:17	118:6 124:14	49:17 54:15 55:16	207:19 209:8	Thirty 188:1
197:9 274:21	136:15 145:6,19	64:17 65:10 70:6	210:19 212:2,22	Thirty-six 395:17
294:22 299:2	155:14 156:7,14	71:9 75:17 78:5,7	213:2,6 214:6	thorium 10:2
321:7 325:6	163:14 166:9	83:22 84:8,11,12	220:15,16 224:8	267:17,18 271:1
344:15 363:6,7	167:16 172:5,22	84:15,18 87:19	225:1,20 228:1	272:18,22 279:22
368:6 373:10	173:20 180:12	88:12,14 92:11,15	236:6 240:1,22	349:17 358:4
404:13	181:16 182:20	92:16 96:8 99:18	243:15 254:16	359:1 361:22
test 32:11,13,17,20	187:16 189:21,21	102:5,11 106:1	259:12,18,19	362:1 364:17
53:16 61:16	194:5 200:16	107:2,3,22 109:6	267:7 270:4,10	366:4,5,16,17
132:19,20 162:9	201:18 204:12	109:19 110:8	274:7,9 275:12,15	367:3 369:20
188:21,22 414:11	208:5 212:6	111:19 112:17,17	275:17 278:19	371:15,16,17,22
testing 32:8	231:21 238:10	112:22 113:7,8,13	279:9 280:2	376:14 377:2,12
tests 43:15	250:11 254:12,17	116:11 121:9	292:14 295:18	378:7 379:3,5,10
tetrafluoride	257:16 271:3	124:2,3,13,21	296:2,6,12 297:6	381:3,16 385:4,7
370:18	286:11 294:18	126:22 127:2	297:9 298:22	385:20 390:18
text 78:20 219:4	299:11 303:6	128:2 129:5,6,12	299:11 301:16	392:3,7 408:10,13
384:14	304:9 306:2	133:5,11,17,21,22	302:14,15 305:8	408:14 409:10,19
thank 5:10 6:18	310:11,15 311:15	134:4,5,6,11	322:20 325:17,19	413:5 419:1

420:14	Till 308:11,13	393:19 397:18	320:16 328:2	382:5,7,12 403:11
Thorium-232	313:20 314:12,15	401:11 408:5	335:9 336:10	405:4,21 406:20
306:3,7 377:7	316:4 324:14	409:14 419:9	339:22 342:5,16	406:22 407:13,15
thoron 349:17	325:16 328:8	timeframe 86:22	342:18 353:11	409:5 410:4
thought 18:14	time 9:5,17,17 13:1	timeliness 259:2	354:11 372:20	415:20 416:2
39:11 45:13 81:13	16:22 21:16 24:19	timely 117:11	topic 117:19 119:5	418:16
108:7 119:20	38:22 47:4 50:1,4	times 66:9 73:7	136:10 197:20	transcribing
135:7 140:22	56:14,21 57:6,14	81:19 103:13	214:6 237:19	382:15
153:1,4 163:17,18	62:17 63:4 70:8,9	133:1 210:10	total 37:19 91:9	transcript 41:14
171:19,21 218:22	75:20 79:18 80:1	212:6 250:10	164:14 199:2	44:15 45:4
236:6 247:2 264:6	81:6 82:14 85:2	253:3 256:2 269:4	201:6 203:19	transcription
307:19 326:15	85:13 99:7 100:12	292:9 318:14	206:21 207:1	137:17 381:21
331:3 376:14	100:17 101:1	363:16 379:17	219:14 290:2	412:11
409:17 418:15	102:15 103:10,16	tip 109:1	330:19 364:4	transcripts 14:22
thousand 34:1	116:14 123:22	tired 421:5	378:9 391:5	102:14
240:5 318:7	124:6 136:1 138:7	Titan 248:15	411:18	transfer 42:20
320:14 329:6	139:6,11 146:4	286:19 288:3	touch 154:5	344:14
thousands 27:21	153:4 155:5	384:5	tower 244:12	transformations
233:5 240:16	172:21 176:16	title 16:5 47:10	245:20 246:8	391:3
thread 362:12	190:19 192:8,21	76:21 95:1 127:11	247:1 250:19	transport 325:1,2
three 13:8 19:17,18	199:11 201:8,10	149:2 150:18,22	263:21 291:1	336:19 344:8
20:5 23:4,8,16,20	209:4 211:18	151:2 201:2	toxic 345:8	347:9
34:14 35:9 52:22	215:18 220:5	229:22 230:5	trace 215:14	transuranics 293:5
54:21 57:4 79:22	223:2 225:13	235:7,20,21 309:3	254:11 256:10	294:21
81:18 164:4	229:20 230:19	314:10 395:10	275:10 280:22	tranuranics 302:1
186:20 228:2	233:5 241:14,22	396:16,17	285:16	trapped 342:12
230:11 233:17	242:1 243:3,7	titled 215:2	traces 276:11	treated 269:8
235:14 238:13	247:8 255:1	titles 76:22 77:3,3	track 15:10 58:7	treatment 309:22
256:14,14,17,20	261:19 263:5,10	84:21 97:11,13	176:16 349:14	310:2 314:18
257:2,9 294:20	277:12 280:20	127:15 202:17	420:10	315:11 317:22
309:2 318:17	282:8,22 285:14	TLDs 186:8,10	trackable 95:19	328:4,10
338:19 340:7	285:15 289:12	today 3:12 9:15,21	tracking 88:22	tremendously
350:13 366:6	294:9,15,17	15:3 99:21 100:4	176:13 420:1	127:12
373:14 381:1,11	305:20 309:12	220:16 273:6	track-etch 348:19	trend 80:7 156:17
390:13 397:2	312:10 314:8	305:12 401:3	tract 357:12,15	trends 156:1
401:19 405:2	318:6 321:5 322:2	413:12 421:3	tractable 122:12,13	181:22 203:18
406:7 408:10,11	323:14,20 324:6,7	toilet 143:21	training 130:5	tried 108:16 293:16
410:6,6,15 411:18	326:15 329:17,18	told 33:7 87:6	transactions	358:9
412:6 413:6 415:7	335:18 336:4	tomorrow 141:16	227:13 228:11	tries 62:22
415:19	338:2 354:21	ton 233:6	257:6,13	trillion 246:1 254:1
three-year 224:5	357:19,20 358:4,5	tons 223:17 227:3	transcends 328:6	trip 346:16
threshold 71:3,4,7	363:14 364:2,3,5	228:3,9 378:10	transcribe 403:20	trips 149:17
throw 33:1 109:11	364:16 369:2,10	top 138:17 227:21	transcribed 46:11	trivial 163:5 174:7
thrown 272:15	369:16 374:20	256:16 310:6	46:17 137:6	174:7
TIB 108:15	376:22 377:22	311:2 314:10	164:19 361:2	trouble 217:11
tie 84:21	378:7,8,15 379:1	315:9,19 316:7	373:4 376:2,8,9	true 33:6 43:8
tight 280:3	383:1 391:12	318:8 319:21	381:4,9,14,15,17	62:11 84:8 114:11

252:7 256:12	380:21 390:20	94:2,10 125:2	356:14 372:18	21:3,6,14 22:3,5
262:1,19 263:2	Twenty 150:7	267:9 363:8	387:3,18 414:20	22:10,13,16 24:14
264:21 289:7	twenty-some 340:6	365:10 368:5,7	understanding	30:17 39:5 50:10
290:21 292:10,19	twist 116:1	372:15 375:19	19:5 215:22	62:6 65:4 71:21
295:4 342:10	two 13:8 18:22 19:7	376:18 390:2	221:20 250:7	99:22 100:18,21
trust 132:15 197:19	19:17,17 21:2,5	typical 284:18	understands 83:22	102:21 103:20
344:13 346:10	21:17,21 22:14	typically 110:20	280:14	117:16 118:7
347:14,15	34:14 35:8 43:18	182:4 207:21	understood 74:16	124:5 136:9 149:9
truth 292:18	54:21 57:4 61:4	282:18 365:2,12	160:8 253:6	150:5 152:21
353:21	76:7,12,14 79:22	367:7	355:18	165:11,19,19,22
try 84:21 110:10	80:15 112:10	typo 323:5	undertaking 360:3	197:11,15 215:4
181:20 189:13	115:18 125:3		under-educated	215:11,12 216:3,4
300:22 327:22	140:7,9 156:11	U	116:7	219:15 223:3,12
346:18 358:11	161:22 164:17,22	U 164:14 278:9	Undoubtedly 299:7	223:14,16,18
368:22 372:17	166:13,21 199:12	ultimate 361:10	unfortunately	224:16 225:5,14
387:22 398:20	200:22 206:22	Ultimately 173:20	161:21	225:16 226:9
414:8,9	207:1 216:1	uncertain 105:8	uniform 98:1 264:1	227:22 228:1,1,7
trying 39:11 49:7	227:15 240:5	uncertainties	370:7	228:9,13,18,20
56:2 73:14,16	242:4,5 244:22	224:19 384:17	uniformity 72:18	229:2,3,4,7,15
83:18 103:8	270:3 288:14	uncertainty 197:6	330:7	230:1,1,2,12,14
116:15 117:7	304:15,17 307:16	287:17 401:9	uniformly 295:14	230:19 231:2,6,9
123:15 128:17	310:13,18 311:16	uncomfortable	unique 34:15 58:1	231:15,20 232:5,8
131:18 136:2	311:18 312:3,6	191:6	unit 295:1	232:9,13,14,21
137:18 141:18	316:9 317:15,16	unconservative	UNITED 1:1	233:2,4,7,8,16
171:21 176:7	320:7,18 321:6	323:16	units 164:14	234:4,4,9,11
177:14 187:21	322:2 323:13	underestimate	unity 322:17	235:6,12 236:3,8
189:12 218:13	324:5,18 331:21	17:20 18:1 30:6	universally 231:5	236:17 237:4,8,10
233:13 235:1	333:1 338:19	31:4 54:20 82:8	283:16	237:20,21 240:10
236:5 239:22	344:9 356:4 358:9	82:18 85:14	University 329:14	241:4,11 244:11
260:1 262:14	359:16 361:4	underestimated	unmonitored 30:4	244:14 245:17,17
289:19 308:4	365:10 367:14,18	324:16 326:9	186:22 187:3	246:13 247:13,22
325:18 338:16	368:18 372:7	underestimates	unusual 283:10	248:1,3,8 254:21
353:8 392:11	375:18 377:11	85:6	un-sampled 107:10	256:9,15,21
394:22 402:20	382:3 390:1,12	underestimating	UO3 229:9 234:2	257:12,17 258:13
tumor 39:4	401:19 405:20	33:19	237:7,16 261:8,9	259:5,8 261:1
turn 119:3 200:7	406:1,7 410:3,12	underneath 345:17	261:11 278:15	265:4 267:11
304:11 306:15	412:7 414:19	underpinning 17:7	279:2	268:2,8,17 271:1
309:2 316:1 343:9	two-step 120:16	understand 48:4	update 352:13	271:11 272:3,11
343:10 357:20	two-year 116:13	49:15 55:11,13,17	updated 418:20	272:17 274:19,22
366:10	type 19:20,21 20:6	55:17 69:7 111:4	updating 350:14,15	275:6 276:5,8,16
turned 82:5 135:17	20:11 89:7 103:17	115:20 133:14	upper 28:15 52:20	277:9,11,14,20
160:15	104:18 108:16	137:7,8 181:11	63:2 64:21 321:19	278:4,5,8 279:15
turns 29:18 35:8	284:18 371:6	235:7 236:5 253:2	uranalysis 133:1	281:11 288:21
65:21 66:7 76:19	375:4,20 377:12	272:19 280:12	267:11,12	289:4 290:5 292:6
76:21 78:3 81:11	377:15 383:2	287:14,21 310:16	uranium 10:1	292:8 296:16
81:13,20 169:11	386:5 390:6	338:16 339:13	14:15 17:4 19:11	297:4 300:20,21
245:12 247:22	types 74:5 92:22	351:4 353:8	19:21 20:6,11	301:21 303:7

304:9 322:8,14,19 349:16 366:3,16 370:4 371:15,21 372:1 377:3,12 379:9,11 408:13 Uranium-234 377:8 uranyl 261:9 urinalysis 149:19 151:15 152:21 156:10 164:13 165:17 urinalysis 207:6 271:22 urine 24:15 26:1 64:13 66:1,6,8 100:4 103:19 133:20 134:5 136:10 149:19 197:7,16 215:12 use 9:2,3 16:6 17:10 30:12 37:6 38:17 55:1 66:18 79:10 82:7 85:12 93:12,13,15 99:20 100:9 104:2,15 106:13 122:9 130:16 138:5 179:12 186:21 193:6 202:8 214:14 260:5 267:11 271:16 280:20 287:15,22 288:16 292:21 325:16 328:4 345:7 349:21 357:3 358:17 377:6 383:13 386:16 useful 57:19 75:13 130:1 140:13 200:14 208:9 299:9 371:5 391:15 397:13 399:8 403:3 usefulness 186:2 uses 75:9 336:17	usually 197:5 201:3 211:15 262:17 318:10 379:3,15 US6 245:17,17 U-plant 261:7 275:2 276:15 277:15 278:4,17 <hr/> V <hr/> vacuum 333:10 valid 126:7 296:13 validate 337:17 validated 229:16 validating 43:13 391:16 validation 43:14 136:19 138:15 288:10,17 validity 39:14 41:17 74:12 117:20 132:4,9 174:17,17 Valley 224:15 262:11 valuable 381:2 value 26:3 28:16 36:7 68:17 104:14 104:14 292:21 293:14 308:1 311:6,10,10 312:3 364:1 values 28:15 68:9,9 68:16,19 69:22 180:20 197:3,5,17 197:20 242:2 247:17 269:7 281:13 308:9 311:20 313:17,18 317:2 340:11 348:3 351:18 372:19 373:2,4 377:15 385:5 400:10 variability 23:9 264:3 400:3 variation 243:20 varied 319:10	variety 38:19 various 16:14 42:21 222:12 249:17 280:22 281:14 329:8 359:22 361:6 371:1 372:21 378:13 vast 30:14 vent 310:4 315:11 343:9,11,12 345:14,22 vented 310:8 320:3 321:10,13 331:6 339:1 340:3 347:21 ventilated 324:5 ventilation 314:1 320:8 323:17 328:12,13 341:11 345:11,12 346:3 355:10,15 venting 319:20 328:10 353:18 Venturi 333:3,9 336:3 345:21 veracity 402:21 verbatim 316:2 verification 149:11 verified 229:16 verify 175:10 377:10 versatile 337:1 version 145:11 164:10 336:18 358:16 359:20 387:5 versions 11:19 versus 37:18 58:12 65:6 126:1 250:2 259:14,14 270:7 311:10,17 338:18 384:18 389:11,19 vett 59:6 vicinity 124:4 view 49:22 72:4 108:1 141:2	162:10 188:17 378:14 virtually 52:12 virtue 340:16 visited 86:16 visitors 11:6 vivo 419:1,20 voice 385:18 398:9 volatile 245:18 volume 320:13 volumes 328:13 vote 160:22 297:8 vow 88:1 vu 39:16 393:9 <hr/> W <hr/> W 322:6 wafting 349:20 wait 54:22 125:13 220:9 wake 372:12 walk 18:19 54:13 86:19 walked 86:17 want 10:5 16:19,20 16:21,21 19:14 29:9,9 42:9 53:16 55:18,18 57:14 60:20 62:12 74:22 76:16 84:2 91:22 93:22 110:12 111:6 113:11 115:15 116:3,16 117:9,18 123:19 123:21 126:2,5,9 126:15 129:5 130:8 135:15 138:6 141:9,11 145:3,6,10 153:3 160:6 162:2,5 181:21,22 185:15 187:17 190:20 192:14 196:20 198:5,6 201:19 202:21,22 204:9 204:12,13,15 205:17 208:6,10	220:5,8 247:11 252:20,22 291:9 297:10 299:12,13 300:8 304:13 305:11 309:8,21 333:17 338:8 339:8 348:11 351:20 352:11 353:1 382:17 395:1 414:20,22 415:4,5 419:15 420:9,14 wanted 19:10 51:1 52:10 74:17 116:19 119:2 131:17 153:12 163:19 220:12,20 279:18,20 304:5 313:16 355:18 wasn't 24:19 69:18 71:7 81:21 82:1 104:12 109:15,16 161:11 164:1,3 166:10 229:20 262:3 301:17,18 304:10 323:7 372:11 380:18 waste 123:22 228:13 262:21 314:1 321:11,12 331:13,18 332:5 332:11,12 335:7 337:4,4 watching 353:3 way 14:20 19:4,4 24:6 29:10 32:8 36:17 44:20,21 49:13 57:16 63:11 72:3 78:16 92:17 95:12 96:9 99:20 103:4 108:15 114:17 123:11 133:7 135:10,11 138:9 152:10 171:22 172:19 173:15 174:22 177:12,15 179:1
--	---	--	---	--

182:6 188:8	8:13 9:15	65:20,22 66:4	354:2,3,19 355:20	234:13 239:17
193:15 200:22	well-founded 243:1	69:15 71:1,2 72:1	361:19 365:22	247:12 264:18
207:19 211:5,8	went 8:11 38:4,8	72:2,14 77:22	366:8 372:9	286:7,18,21
213:20 222:15	40:7 41:3 44:14	79:17 80:3,22	377:20 381:20	288:12 296:4
224:7 231:10,15	45:4 46:5 55:11	83:3 91:16 96:19	384:1 402:20	299:19 302:19,21
238:14 240:15	55:12 89:13 95:7	101:17,18 103:8,8	405:2 410:10	303:3 304:7,19
245:3 250:7	95:13,15 114:7	111:5 112:5	413:17 418:16	305:22 306:21
260:22 287:8	118:14 126:20	115:17 116:14	420:15,15 421:5	338:22 339:3
292:8 297:3	152:13 159:7	117:9,18 118:10	we've 9:17 10:4	358:16 359:20
305:17 325:6,18	184:17 188:21	119:17 120:14	28:17 31:11 33:22	367:1 373:1
329:15 330:6	199:15 212:10,13	121:12 123:7,15	37:16,18 38:13	385:22 387:6
334:6 339:9	223:21 230:20	125:22 128:21,22	40:4 61:4,11	388:6,22 396:21
346:16 347:12	234:2 270:7 277:5	130:10 131:3	79:18 91:10,11,16	396:22 397:2
348:2 353:7 363:3	290:19 303:19	138:16 140:15,19	91:18 97:13	400:6,8 401:1
369:18 377:6	307:3 327:8	142:16 146:3	114:22 115:1,2,5	402:18 403:6,21
378:3,16,22	329:15 335:12	147:17 148:15	115:6,7,11 118:5	412:3 413:11
418:17	355:11 390:22	154:6 163:15	123:1 126:18	414:5,8 415:3
ways 70:2 98:11	391:11,21 403:17	164:7 168:7 171:8	135:16 141:4,5	418:12,17 419:19
138:14 279:14	weren't 58:20	177:12 178:9	154:11 157:6,9	420:17
341:13	156:11	179:15 181:19	161:7,21 162:8	Whitetail 244:16
weak 27:7 34:19	West 224:15	183:8 189:17	164:21,22 175:2,8	Whoa 27:15
weakness 61:20	262:11	192:12 193:20,21	177:18,20 180:14	wide 243:20 297:19
weaknesses 54:3	we'll 11:5 15:20	194:6 195:8,10	183:5 184:16	wind 336:3 348:5
wealth 260:18	22:19 54:7 104:5	198:8,14 199:7,9	185:8 186:22	window 99:4
371:10	104:9,10 109:6	212:16 214:21	187:13 188:11	139:11
weapons 265:6	118:12 140:14	221:21 234:5	191:2,5 196:1	windows 99:6
wearing 247:5	147:21 148:9	235:1,3 247:9	198:9 220:3	wish 47:3 108:7
web 144:17	154:2,20,20	249:14,22 250:3	233:12 266:9	witness 6:8
WEDNESDAY	198:12 200:7,13	251:4,13 255:20	268:9 271:13	women 186:19
1:13	238:5,7 302:19	256:22 259:13	272:6,8,15 279:8	wonder 179:5
weeds 353:1	303:15 317:13	260:5,8 262:7	279:9,12 280:2	394:8
week 11:20 47:9	334:21 356:9	265:15,16 268:5	286:12 289:18	wondered 379:19
142:10 143:1	376:3,11 383:14	268:15 269:22	290:7 293:20	wonderful 116:10
390:16	387:13,14 388:10	271:4 273:5,7,11	294:5 296:7 297:9	wondering 8:8
weekly 207:4	404:20 419:9	279:13 280:17	304:12,14 349:12	383:9
weeks 305:14,15	we're 3:9,13 9:15	281:8 283:5,6,11	351:3 355:22	Word 412:5
366:6	9:21 10:1 11:10	283:12 288:21	356:5,9 357:15	words 13:20 25:3
weigh 172:4 263:4	14:12 22:2,15,18	289:10,19,22	379:2 386:17	47:16 69:16 72:11
weighs 229:10	25:17,19 26:16	290:7,16 295:19	387:7 391:7 410:3	78:8,10 82:4
weight 363:2	30:6,10,19 31:21	295:20 299:3	412:10 414:4	95:13 100:8
392:20 395:13,16	32:12,14,19 34:13	300:4 302:20	416:12 417:18	112:15 122:10
396:14 397:4	34:16 35:6 36:16	303:16 304:2	420:5	139:8 147:1
weighted 306:4	40:18,22 42:1	305:1 311:13	whatsoever 365:21	155:18 157:15,18
358:17 364:6	44:2,17,18 45:8	331:20 337:16	what-if 273:10	177:7 202:12
397:16	53:18 54:6,11,15	344:1,10 346:15	white 102:8 115:9	203:14 206:11
welcome 3:4 5:10	55:14 57:22 60:17	348:3 351:22	136:6 215:5 220:1	268:16 269:2
6:17 7:10,20 8:1,7	61:5 63:4 65:12	353:5,6,12 354:1	225:1,22 226:6,12	281:14 289:9

315:8 325:15	209:20 210:2	354:22 368:9	wrote 269:2 304:19	39:3,4 50:4 56:7
327:4 407:4 414:2	271:12 290:9	385:20 386:3,21		58:16 60:16 66:14
work 3:22 4:1,4,6	304:1 387:10,16	worker's 22:7	<hr/> X <hr/>	68:7 75:14 76:5
9:16 11:22 14:10	394:8	183:17 394:9	X 99:21 255:21	77:12 80:12,14
21:18 28:4,22	workers 3:6 16:7	workgroup 1:10,15	407:11	86:21 105:2,9
29:6,12 33:15	16:15,16 17:5,10	44:13 304:2	x-rays 271:2	107:14 112:6
35:13 55:10 69:19	17:21 18:2,8,11	working 3:4,20		115:18 125:6,15
78:2 82:20 83:14	21:13 27:21 28:8	30:11 36:20 42:8	<hr/> Y <hr/>	127:13 132:12,13
83:19 84:3 85:19	28:22 29:3,19	46:3,21,22 47:2	year 9:19 11:6	145:20 146:12
103:4 106:16	30:4,11 31:3 33:5	52:13 56:15 60:3	24:15 27:14,20	156:12 161:22
107:14 114:13,17	33:17 34:14 35:2	74:6,15,16 81:17	28:1,4,10,22 29:4	184:3 186:11
116:11 123:16	35:7,8,9,17 36:10	98:12,13 99:17	29:15 47:10 48:5	187:8 191:14
124:15 133:10	36:12,17,17 37:11	118:18 130:18	48:13 49:11,19	202:16 203:20
143:13 147:14,19	37:14 44:4,9	158:10 160:4,6	50:15,19 51:7,7	204:21 205:18
147:20 148:10	45:12 47:3,8 48:3	175:4 199:21	51:18,21 52:8	208:8,12,12
162:16 166:11	48:21,22 49:10	205:8 207:20	56:9,9 57:11,12	209:21 257:2
173:1 174:5 180:9	50:1,2,7,13 56:8	221:9,12 241:13	66:6 67:1 70:19	262:17 263:18
196:15,16 205:14	57:1,3,4,9 58:12	243:7 273:7 296:1	75:3 76:6,11	266:5 286:11,15
213:7 215:6	58:12,15,18,19,20	349:4 359:6 419:4	83:11 87:13 98:6	328:15 331:12,16
242:12 270:15	59:2 62:1,5,11,15	works 70:5	98:8,13 99:5	331:20,21 356:5
273:9 283:13	63:13 64:1 65:4	worksheet 396:12	105:6 111:2	359:22 360:8,10
291:20 304:22	66:3,5,7,9 70:11	worksheets 408:11	132:18 134:17	361:6,13,22 366:9
305:4,19,21 306:9	71:20 73:8 74:6	worried 252:13	139:9 157:15	372:20 375:5
308:2 310:6	77:21 79:21 80:8	worst 272:15	158:6 190:12	381:15 401:22
352:18 388:12	80:14,17 82:13	worth 32:22 82:21	203:13,14 205:1,3	404:10,12,22
389:3 406:12	83:8 86:9,12	107:22 136:2	205:20 206:10,14	405:1 419:1
412:20,21 414:20	87:11 88:1 92:15	378:5,19 399:2	207:3,3,3,6	yellow 352:17
worked 20:8,16	98:3,11 99:2	worthwhile 376:15	208:18,21 209:9	yield 380:3
21:14 59:8,10	101:22 107:13	wouldn't 18:21	209:18 228:5,8	young 174:2
62:16 63:14 75:2	120:11,22 121:3	55:1 69:11 82:10	230:19 233:18	
82:14 83:10 85:9	124:5 125:19	87:16 93:12 96:4	265:3 266:10,17	<hr/> Z <hr/>
86:21 87:13 95:15	132:13 157:14	96:5,7 97:9	294:11 305:3	zero 34:3 37:9,9
111:22 112:9	158:5 162:19	110:22 127:6,7	307:18,22 308:7	84:20 104:9
114:1 126:4 128:3	167:10,11 169:16	152:22 184:15	309:22 313:9	211:16,19 215:18
130:4 156:8 163:1	170:18,21 171:13	258:5 341:12	324:4,6 326:4	321:20 331:19
184:3 191:14	172:8,21 175:9	wrapped 118:1	329:6 338:22	zeroes 201:14
201:5 202:16	185:2,5 188:19	wrestle 289:19	359:6,10 360:16	Ziemer 1:21 4:1,1
worker 7:18,22	189:3 210:8,12	writing 401:3	366:3,7,17 367:6	11:15 12:10,13
19:9,14,20 20:8	212:13 215:3	written 154:16	367:6 371:18	23:15 47:21 48:2
20:15,17 36:1,19	246:12,14,19	215:20 221:5	378:10,17 379:17	48:7,9,12,16,19
37:10 40:10 48:9	247:5 268:18	wrong 55:6 98:17	385:7 391:5,7	49:6,9,14 52:12
51:7,18,20 63:19	273:18 285:18	125:13 126:22	392:21 396:6	67:9,12,20 92:3
81:20 118:17	287:19 290:4,11	138:9 140:4,4,5	402:1,4 406:5	98:5 107:1,21
124:7 178:16	291:13 294:4	166:19 190:3	411:4	108:4,9 114:6
182:21,22 184:2	302:8,13 310:6	231:6,11 250:15	yearly 156:10	119:20 120:5
189:8 192:19	315:9 329:16	305:9 344:12	378:17	122:2 136:16
199:20 201:8,10	350:1,12 351:17	353:16	years 18:8 20:16	137:7,18 138:1
			29:4 30:10 37:2,3	

140:7,12,19	zone 306:4 310:21	326:10	120 167:18	359:2 368:19
141:13,20 142:1,6	363:8 364:13	10th 149:2 150:20	123,000 311:17	373:13
142:15,18,22	365:8 373:11,16	10,040 125:19	13 66:3,5 167:9	1955 227:20 228:5
143:6,14,18 144:4	373:18,21 375:7	10-A 250:12,19	322:21	360:6 361:18
144:19 145:3,7	375:11,16 384:8	251:12	133 77:11,18	367:2 369:17
147:17,20 148:1,6	384:18 389:11	10-minute 302:16	14 200:10,10,12	371:18 372:2
148:14 150:16	391:9,13 395:4	303:12	202:6 205:21	406:5 407:5 410:2
158:7,17,20 159:3	zones 310:21	10-year 209:20	287:3	410:8 411:16
159:6,12 160:1,7	389:19	10:13 40:7	14th 200:22	412:8 415:16
160:11 168:16,21	Zurich 1:15	10:14 40:8	15 97:8 183:12	416:12,17 417:14
172:11,17 174:8		100 59:12 72:18	196:1,4 207:1	417:17,19,22
174:12 175:7,11	0	75:15 76:13 97:8	210:22 211:2,4,6	1956 73:5 75:4
175:20 176:6,21	0.2 300:2	101:15 102:2	211:7,9 214:2	157:13 417:1
177:3,7,9,19,22	0.38 312:4	137:10 138:16	313:14 330:17	1957 35:1 36:2,8,16
178:2 184:5,9	0.72 312:4	139:17,19 140:16	150 66:20 71:4	98:3 227:13
191:7,12,18,22	03 230:19	142:18 152:12	166:22 167:9	1958 313:8
192:2,7 196:3	03-24-2009 410:21	241:9 242:22	168:5 170:8	1960 360:7 361:20
200:18 204:17	04-16 411:3,12	243:4 244:1	171:21 187:18	405:11 407:19
205:5,11,17	04-16-2000 410:22	247:17 250:16	188:13 191:6,9	415:15 417:4
207:13,20 208:2	06 377:19	251:9,22 259:13	194:3 195:9	1961 113:14 226:8
211:21 213:19	07 9:18	268:14 270:7	152 360:20	228:17 229:15
214:2 216:13,19	1	272:21 273:19	16 38:10 56:21 89:9	231:10,20 234:14
217:4,8,11,15,20	1 24:9 63:3,14 65:5	274:1 279:10	91:19 284:10	268:19 380:22
218:4,6,12,17	75:4 98:12,13	280:11 287:1	323:3,6 363:12	1964 244:10 316:8
219:8,13,16	227:20 319:3	288:22 289:20	373:14,17,22	316:19
234:19,20,22	1A 249:17	290:12 291:19	16th 399:21 402:8	1966 360:6 361:18
235:11,15,19	1B 249:17	318:15 321:20	160 360:12,12	406:5 407:7
236:4,12,16,19	1,000 97:8 140:16	331:10 365:15	167 360:14	415:16 417:7,10
237:2,6,22 238:20	162:3 328:11	375:11 382:10	168 317:19	1968 358:20 359:2
239:2,5,9,13,21	1,040 37:18 91:8,9	100,000 142:19	17 57:13	1969 375:3
240:3,6,9,13,18	1,500 416:10	324:4,17 338:18	171 381:8	1970 36:21 42:6,8
294:14,22 295:4	1-A 250:10 251:12	100-millirem 59:3	18 57:20	42:14 145:22
296:6,10 301:1,10	1-1 19:7	11 118:11 216:5,6	181 63:22 64:20	156:7
302:18 312:11,15	1-3 20:5	216:21 217:5	66:2 67:9,11,12	1972 316:20
330:14,15 331:2	1.2 328:13	219:6 221:3,17	19 369:5,8	1977 327:2
337:22 338:5,9,15	1.5 66:18 71:4	241:1 320:20	193 317:20 319:6	1979 309:14 316:14
339:7,12,17	1.6 23:19	350:17 374:10,15	194,000 311:10	320:22 321:1
342:20 346:21	1.8 66:9	398:6 405:5	1950 105:4 179:11	323:22,22 324:7
347:18 348:5,21	1.81 67:10,19	11/13 9:18	1950s 274:18	332:14 342:6
349:5,10 353:20	1/1/52 20:8	11:20 118:14	1951 60:16 277:13	343:14
374:10,15 395:2	1:50 199:16	11:30 118:12	1952 34:16,17	1980 58:5 60:5
395:17 396:18	10 204:21 209:21	11:38 118:15	50:12 56:7 203:15	284:7
407:1 412:19	211:17,20 212:13	110 77:19	275:3	1980s 285:8 342:22
413:1 418:11	217:9,16 219:4	119 369:21	1953 63:3,14 65:5	1985 58:11 223:22
zinc 364:19 370:21	241:1 268:8,11	12 381:18,18 405:5	65:22 313:8	266:15
zirconium 218:19	289:15 290:8	12/31/53 20:9	373:14 416:20	1987 310:1 314:17
219:2,5,6	298:5 316:1 319:3	12:43 199:16	1954 209:1 227:20	317:18 319:5,9

1989 59:2 60:16 127:1 179:10	230:16 237:11 239:7 240:3 257:3 257:19,21 260:8 260:14 263:15 264:19 265:12	3	4.3-6 362:14 40 172:8 207:12 211:17 272:6,7 331:9,11,13,20,20	399:22 402:9 52 24:18 34:19 36:5 36:10,20 201:5 208:15,17 209:8 212:9
1990 126:4 128:14 129:22 186:6	2006 25:12,13 115:17 208:8	3 37:14 63:15 75:5 79:5,8 112:9 166:20	40.4 91:14 400 321:8 353:14 374:7	525,000 311:11 53 24:18 34:16,20 48:20 50:12 56:7 68:6 203:15 226:10 233:5 278:1 303:6
1991 310:9,18 323:12 331:11,20	2007 126:4 131:15 146:7	3,000 35:7 392:2 3,118 284:9 3,500 281:8	400,000 33:22 34:6 124:4	54 24:20 63:15 203:16 208:15,17 209:12,14 226:10 228:8 369:3,13 416:6 418:5
1993 312:1	2008 126:5 149:2 150:20 219:5 255:22 256:8,8 304:21 306:22 307:2 358:6 359:6 384:12	3-3 217:20,21 218:21	406,145 164:13 4076 152:21 412.77 300:2 431,016 164:12 435,982 164:12 463 365:15 47 277:12 49.95 143:1	54(a)(11) 59:19 54(a)(35) 59:19 55 63:15 319:7 369:19 379:13 405:9,10,20 406:6 407:9,16 415:8 417:15
1995 308:10,13,16 309:7 313:10,19 314:12 324:14	2009 1:13 16:4 215:1 216:12 305:5 362:6 367:1 411:20	3-3 217:20,21 218:21 3-7 218:4 235:4 3.44 20:13 3/10/2008 151:8 3:35 303:19 3:50 303:20 30 158:4 188:2 191:8,11 193:18 194:2 203:20 204:1 207:11,17 211:17 212:21 227:20 239:9 286:11 316:21 317:7 341:21 342:3 363:10,21 367:8	431,016 164:12 435,982 164:12 463 365:15 47 277:12 49.95 143:1	54(a)(11) 59:19 54(a)(35) 59:19 55 63:15 319:7 369:19 379:13 405:9,10,20 406:6 407:9,16 415:8 417:15
1999 266:17	2009 1:13 16:4 215:1 216:12 305:5 362:6 367:1 411:20	30,000 338:18 300 162:5 166:22 167:6 257:14	5	55-gallon 229:10 55-minute 394:2 56 36:5,11 63:15 212:9 371:20 372:1 416:6 560 377:13 57 36:12,22 103:19 103:19 261:22 371:20,22 571 91:17 92:1 58 34:20 103:21 227:3 261:22 59 48:20,22 407:20
2	2009 1:13 16:4 215:1 216:12 305:5 362:6 367:1 411:20	300-A 257:7 31 61:14 32 66:1,6 381:7 33 149:21 153:7,10 35 188:22 189:2 343:13 35.5 319:6 37 284:9 311:12,12 38 311:17 331:9	5 75:5 98:17 247:12 5th 239:12 5,000 307:17 308:7 313:8 324:13 5.1 250:10 5.2.4 312:19 5:45 421:8 50 33:13 34:3 38:7 38:11 44:3 58:13 65:20 89:8,11,21 89:21 91:15,17 92:1 105:2,9 110:4 111:21 123:3 124:16 125:1,11,11 172:8 191:11 211:17 259:14 267:14,19 267:21,22 270:21 272:14 281:10	55 63:15 319:7 369:19 379:13 405:9,10,20 406:6 407:9,16 415:8 417:15 55-gallon 229:10 55-minute 394:2 56 36:5,11 63:15 212:9 371:20 372:1 416:6 560 377:13 57 36:12,22 103:19 103:19 261:22 371:20,22 571 91:17 92:1 58 34:20 103:21 227:3 261:22 59 48:20,22 407:20
2 24:8 63:15 73:6 75:9 111:22 112:1 112:5,7,8 164:10 190:13	2009 1:13 16:4 215:1 216:12 305:5 362:6 367:1 411:20	4 75:5 314:17 4,000 34:14 35:7,8 35:9 37:14 98:3 4-3 217:9,16 218:18 4.2-1 350:9 4.2-2 284:5 4.2-3 307:10 4.3-1 362:10 4.3-10 362:11	5 75:5 98:17 247:12 5th 239:12 5,000 307:17 308:7 313:8 324:13 5.1 250:10 5.2.4 312:19 5:45 421:8 50 33:13 34:3 38:7 38:11 44:3 58:13 65:20 89:8,11,21 89:21 91:15,17 92:1 105:2,9 110:4 111:21 123:3 124:16 125:1,11,11 172:8 191:11 211:17 259:14 267:14,19 267:21,22 270:21 272:14 281:10	55 63:15 319:7 369:19 379:13 405:9,10,20 406:6 407:9,16 415:8 417:15 55-gallon 229:10 55-minute 394:2 56 36:5,11 63:15 212:9 371:20 372:1 416:6 560 377:13 57 36:12,22 103:19 103:19 261:22 371:20,22 571 91:17 92:1 58 34:20 103:21 227:3 261:22 59 48:20,22 407:20
2,400 34:21 2,735 228:9	2009 1:13 16:4 215:1 216:12 305:5 362:6 367:1 411:20	4 75:5 314:17 4,000 34:14 35:7,8 35:9 37:14 98:3 4-3 217:9,16 218:18 4.2-1 350:9 4.2-2 284:5 4.2-3 307:10 4.3-1 362:10 4.3-10 362:11	5 75:5 98:17 247:12 5th 239:12 5,000 307:17 308:7 313:8 324:13 5.1 250:10 5.2.4 312:19 5:45 421:8 50 33:13 34:3 38:7 38:11 44:3 58:13 65:20 89:8,11,21 89:21 91:15,17 92:1 105:2,9 110:4 111:21 123:3 124:16 125:1,11,11 172:8 191:11 211:17 259:14 267:14,19 267:21,22 270:21 272:14 281:10	55 63:15 319:7 369:19 379:13 405:9,10,20 406:6 407:9,16 415:8 417:15 55-gallon 229:10 55-minute 394:2 56 36:5,11 63:15 212:9 371:20 372:1 416:6 560 377:13 57 36:12,22 103:19 103:19 261:22 371:20,22 571 91:17 92:1 58 34:20 103:21 227:3 261:22 59 48:20,22 407:20
2-1 27:13 68:14	2009 1:13 16:4 215:1 216:12 305:5 362:6 367:1 411:20	4 75:5 314:17 4,000 34:14 35:7,8 35:9 37:14 98:3 4-3 217:9,16 218:18 4.2-1 350:9 4.2-2 284:5 4.2-3 307:10 4.3-1 362:10 4.3-10 362:11	5 75:5 98:17 247:12 5th 239:12 5,000 307:17 308:7 313:8 324:13 5.1 250:10 5.2.4 312:19 5:45 421:8 50 33:13 34:3 38:7 38:11 44:3 58:13 65:20 89:8,11,21 89:21 91:15,17 92:1 105:2,9 110:4 111:21 123:3 124:16 125:1,11,11 172:8 191:11 211:17 259:14 267:14,19 267:21,22 270:21 272:14 281:10	55 63:15 319:7 369:19 379:13 405:9,10,20 406:6 407:9,16 415:8 417:15 55-gallon 229:10 55-minute 394:2 56 36:5,11 63:15 212:9 371:20 372:1 416:6 560 377:13 57 36:12,22 103:19 103:19 261:22 371:20,22 571 91:17 92:1 58 34:20 103:21 227:3 261:22 59 48:20,22 407:20
2.0 336:18	2009 1:13 16:4 215:1 216:12 305:5 362:6 367:1 411:20	4 75:5 314:17 4,000 34:14 35:7,8 35:9 37:14 98:3 4-3 217:9,16 218:18 4.2-1 350:9 4.2-2 284:5 4.2-3 307:10 4.3-1 362:10 4.3-10 362:11	5 75:5 98:17 247:12 5th 239:12 5,000 307:17 308:7 313:8 324:13 5.1 250:10 5.2.4 312:19 5:45 421:8 50 33:13 34:3 38:7 38:11 44:3 58:13 65:20 89:8,11,21 89:21 91:15,17 92:1 105:2,9 110:4 111:21 123:3 124:16 125:1,11,11 172:8 191:11 211:17 259:14 267:14,19 267:21,22 270:21 272:14 281:10	55 63:15 319:7 369:19 379:13 405:9,10,20 406:6 407:9,16 415:8 417:15 55-gallon 229:10 55-minute 394:2 56 36:5,11 63:15 212:9 371:20 372:1 416:6 560 377:13 57 36:12,22 103:19 103:19 261:22 371:20,22 571 91:17 92:1 58 34:20 103:21 227:3 261:22 59 48:20,22 407:20
2.4 98:3	2009 1:13 16:4 215:1 216:12 305:5 362:6 367:1 411:20	4 75:5 314:17 4,000 34:14 35:7,8 35:9 37:14 98:3 4-3 217:9,16 218:18 4.2-1 350:9 4.2-2 284:5 4.2-3 307:10 4.3-1 362:10 4.3-10 362:11	5 75:5 98:17 247:12 5th 239:12 5,000 307:17 308:7 313:8 324:13 5.1 250:10 5.2.4 312:19 5:45 421:8 50 33:13 34:3 38:7 38:11 44:3 58:13 65:20 89:8,11,21 89:21 91:15,17 92:1 105:2,9 110:4 111:21 123:3 124:16 125:1,11,11 172:8 191:11 211:17 259:14 267:14,19 267:21,22 270:21 272:14 281:10	55 63:15 319:7 369:19 379:13 405:9,10,20 406:6 407:9,16 415:8 417:15 55-gallon 229:10 55-minute 394:2 56 36:5,11 63:15 212:9 371:20 372:1 416:6 560 377:13 57 36:12,22 103:19 103:19 261:22 371:20,22 571 91:17 92:1 58 34:20 103:21 227:3 261:22 59 48:20,22 407:20
2.5 73:6	2009 1:13 16:4 215:1 216:12 305:5 362:6 367:1 411:20	4 75:5 314:17 4,000 34:14 35:7,8 35:9 37:14 98:3 4-3 217:9,16 218:18 4.2-1 350:9 4.2-2 284:5 4.2-3 307:10 4.3-1 362:10 4.3-10 362:11	5 75:5 98:17 247:12 5th 239:12 5,000 307:17 308:7 313:8 324:13 5.1 250:10 5.2.4 312:19 5:45 421:8 50 33:13 34:3 38:7 38:11 44:3 58:13 65:20 89:8,11,21 89:21 91:15,17 92:1 105:2,9 110:4 111:21 123:3 124:16 125:1,11,11 172:8 191:11 211:17 259:14 267:14,19 267:21,22 270:21 272:14 281:10	55 63:15 319:7 369:19 379:13 405:9,10,20 406:6 407:9,16 415:8 417:15 55-gallon 229:10 55-minute 394:2 56 36:5,11 63:15 212:9 371:20 372:1 416:6 560 377:13 57 36:12,22 103:19 103:19 261:22 371:20,22 571 91:17 92:1 58 34:20 103:21 227:3 261:22 59 48:20,22 407:20
2/1961 113:19	2009 1:13 16:4 215:1 216:12 305:5 362:6 367:1 411:20	4 75:5 314:17 4,000 34:14 35:7,8 35:9 37:14 98:3 4-3 217:9,16 218:18 4.2-1 350:9 4.2-2 284:5 4.2-3 307:10 4.3-1 362:10 4.3-10 362:11	5 75:5 98:17 247:12 5th 239:12 5,000 307:17 308:7 313:8 324:13 5.1 250:10 5.2.4 312:19 5:45 421:8 50 33:13 34:3 38:7 38:11 44:3 58:13 65:20 89:8,11,21 89:21 91:15,17 92:1 105:2,9 110:4 111:21 123:3 124:16 125:1,11,11 172:8 191:11 211:17 259:14 267:14,19 267:21,22 270:21 272:14 281:10	55 63:15 319:7 369:19 379:13 405:9,10,20 406:6 407:9,16 415:8 417:15 55-gallon 229:10 55-minute 394:2 56 36:5,11 63:15 212:9 371:20 372:1 416:6 560 377:13 57 36:12,22 103:19 103:19 261:22 371:20,22 571 91:17 92:1 58 34:20 103:21 227:3 261:22 59 48:20,22 407:20
20 71:8 118:11 145:13 157:13 158:4 162:13 170:7 184:1 202:16 211:17 213:21 304:16 313:14 363:10,20	2009 1:13 16:4 215:1 216:12 305:5 362:6 367:1 411:20	4 75:5 314:17 4,000 34:14 35:7,8 35:9 37:14 98:3 4-3 217:9,16 218:18 4.2-1 350:9 4.2-2 284:5 4.2-3 307:10 4.3-1 362:10 4.3-10 362:11	5 75:5 98:17 247:12 5th 239:12 5,000 307:17 308:7 313:8 324:13 5.1 250:10 5.2.4 312:19 5:45 421:8 50 33:13 34:3 38:7 38:11 44:3 58:13 65:20 89:8,11,21 89:21 91:15,17 92:1 105:2,9 110:4 111:21 123:3 124:16 125:1,11,11 172:8 191:11 211:17 259:14 267:14,19 267:21,22 270:21 272:14 281:10	55 63:15 319:7 369:19 379:13 405:9,10,20 406:6 407:9,16 415:8 417:15 55-gallon 229:10 55-minute 394:2 56 36:5,11 63:15 212:9 371:20 372:1 416:6 560 377:13 57 36:12,22 103:19 103:19 261:22 371:20,22 571 91:17 92:1 58 34:20 103:21 227:3 261:22 59 48:20,22 407:20
20-something 180:21	2009 1:13 16:4 215:1 216:12 305:5 362:6 367:1 411:20	4 75:5 314:17 4,000 34:14 35:7,8 35:9 37:14 98:3 4-3 217:9,16 218:18 4.2-1 350:9 4.2-2 284:5 4.2-3 307:10 4.3-1 362:10 4.3-10 362:11	5 75:5 98:17 247:12 5th 239:12 5,000 307:17 308:7 313:8 324:13 5.1 250:10 5.2.4 312:19 5:45 421:8 50 33:13 34:3 38:7 38:11 44:3 58:13 65:20 89:8,11,21 89:21 91:15,17 92:1 105:2,9 110:4 111:21 123:3 124:16 125:1,11,11 172:8 191:11 211:17 259:14 267:14,19 267:21,22 270:21 272:14 281:10	55 63:15 319:7 369:19 379:13 405:9,10,20 406:6 407:9,16 415:8 417:15 55-gallon 229:10 55-minute 394:2 56 36:5,11 63:15 212:9 371:20 372:1 416:6 560 377:13 57 36:12,22 103:19 103:19 261:22 371:20,22 571 91:17 92:1 58 34:20 103:21 227:3 261:22 59 48:20,22 407:20
200 172:21 173:1 259:14 342:11	2009 1:13 16:4 215:1 216:12 305:5 362:6 367:1 411:20	4 75:5 314:17 4,000 34:14 35:7,8 35:9 37:14 98:3 4-3 217:9,16 218:18 4.2-1 350:9 4.2-2 284:5 4.2-3 307:10 4.3-1 362:10 4.3-10 362:11	5 75:5 98:17 247:12 5th 239:12 5,000 307:17 308:7 313:8 324:13 5.1 250:10 5.2.4	

60,000 305:2 326:4	87 323:7 343:7
600 92:1,8 174:4	89 60:18 126:12,20
61 139:12 226:13	127:4,4,22 128:3
241:15 261:21	128:8 129:13,14
289:2,3 290:14	130:4 208:8
380:19	212:14
62 233:5	
63 380:19,22	9
64 244:22 379:20	9 75:5 250:11
64,000 394:10	251:12
64,778 393:11	9.16 300:2
645 144:1	9:30 1:16
65 355:8,11	9:38 3:2
66 405:10,20	90 30:10 33:4,5
406:14 407:16	34:16,17 49:4
415:8 416:6	57:8 62:10,11
660 339:1	91:11 150:12
67 218:20	170:20 188:19
68 319:7,13	317:8 323:6
69 114:7 190:3,7	349:12 357:14
7	90s 25:1
7 75:5	90th 386:18
70 190:3 204:3	90,000 305:2
355:8,12 365:14	307:21
367:8	900 174:5 177:20
70s 36:18 146:2,15	229:11
70's 285:13	91 312:2
72 201:5 278:8	92 33:7 265:5
316:9,10,11	93 33:7
73 316:10,11	95 34:2 35:1 44:3
75 204:3 316:20	312:8 316:4
321:3 331:22	95th 28:14 87:17
79 328:16 332:14	122:9 125:7 385:5
340:1 355:14	402:12
379:20	950 182:3
8	958 91:10
8 75:5 250:11	96 361:20 407:9
251:12	97 319:16 332:19
8,197 20:12	98 35:1
80s 146:16	99 290:9
83 309:20	
84th 23:12,21 25:6	
25:21 28:21 78:10	
78:11,13 79:1,4,9	
79:14 400:1	
86 309:20	